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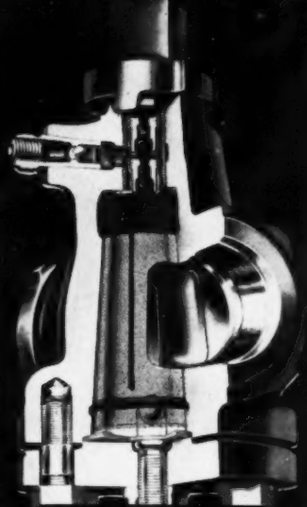

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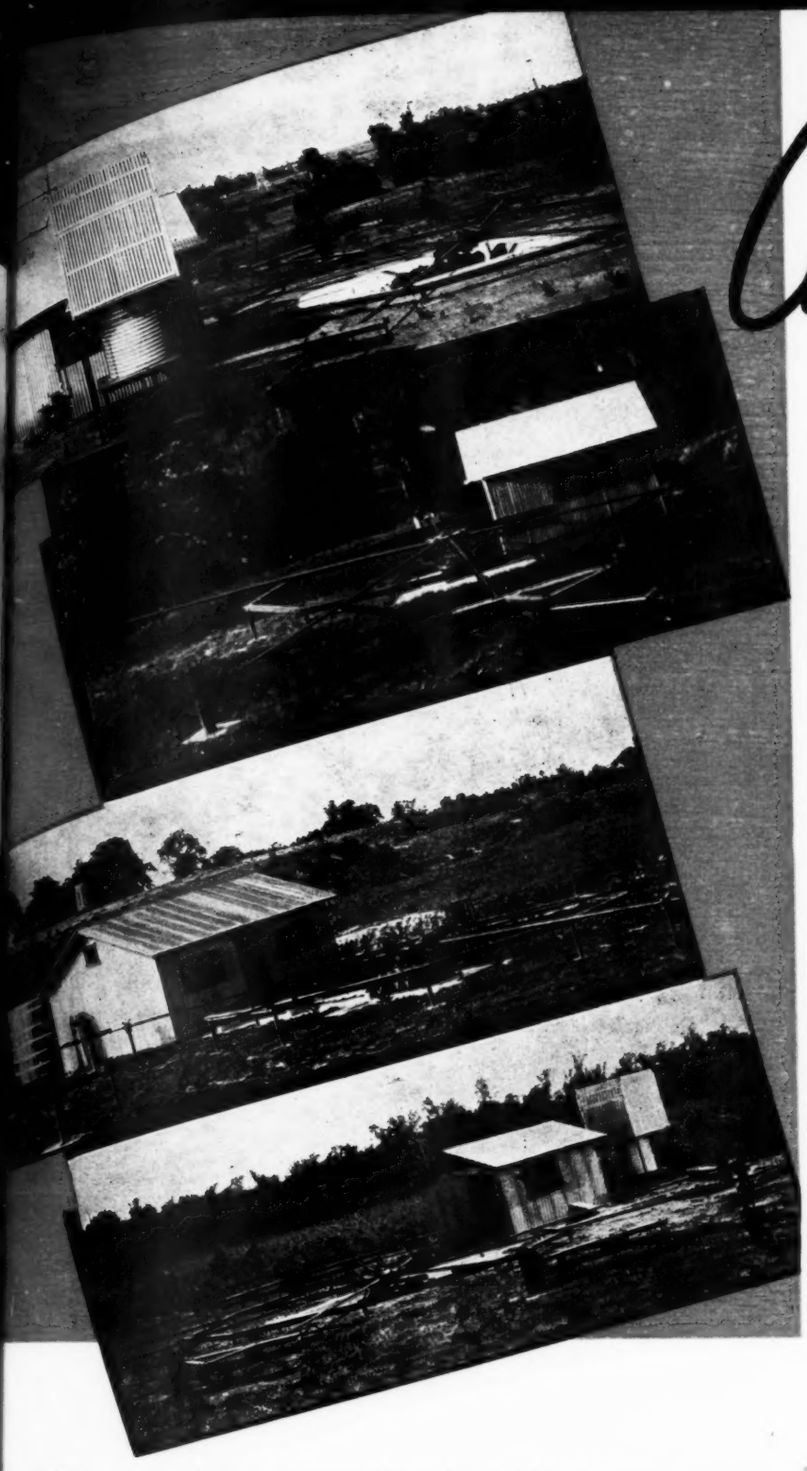

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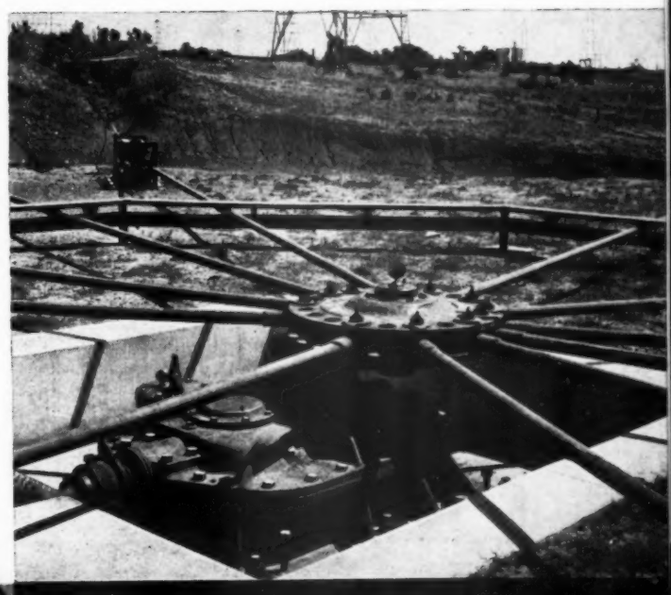

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THE Petroleum Engineer

AUGUST 1938

VOLUME IX NUMBER 12

A MAGAZINE OF METHODS FOR OPERATING MEN

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MEETINGS

California Natural Gasoline Association — September 1, Richfield Building, Los Angeles, California.

•

American Chemical Society—September 5, 6, 7, 8, and 9, Milwaukee, Wisconsin.

•

American Association of Petroleum Geologists, Mid-Year Meeting—September 27, 28, 29, 30, October 1, and 2, El Paso, Texas.

•

Society of Automotive Engineers, National Regional Fuels and Lubricants Meeting—October 6 and 7, Tulsa, Oklahoma.

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American Institute of Mining and Metallurgical Engineers, Petroleum Division—October 6 and 7, San Antonio, Texas.

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American Gas Association—October 10, 11, 12, 13, and 14, Atlantic City, New Jersey.

•

National Stripper Well Association, Annual Meeting—October 18, Tulsa, Oklahoma.

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Oklahoma Stripper Well Association, Annual Meeting — October 18, Tulsa, Oklahoma.

•

Independent Petroleum Association of America—October 19, 20, and 21, Tulsa, Oklahoma.

•

Mid-Continent Oil and Gas Association, Texas Division—October 27, 28, and 29, San Antonio, Texas.

•

American Association of Petroleum Geologists, Pacific Section—November 3 and 4, Los Angeles, California.

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American Petroleum Institute, 19th Annual Meeting—November 14, 15, 16, 17, and 18, Stevens Hotel, Chicago, Illinois.

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American Society of Mechanical Engineers—December 4, 5, 6, 7, 8, and 9, Philadelphia, Pennsylvania.

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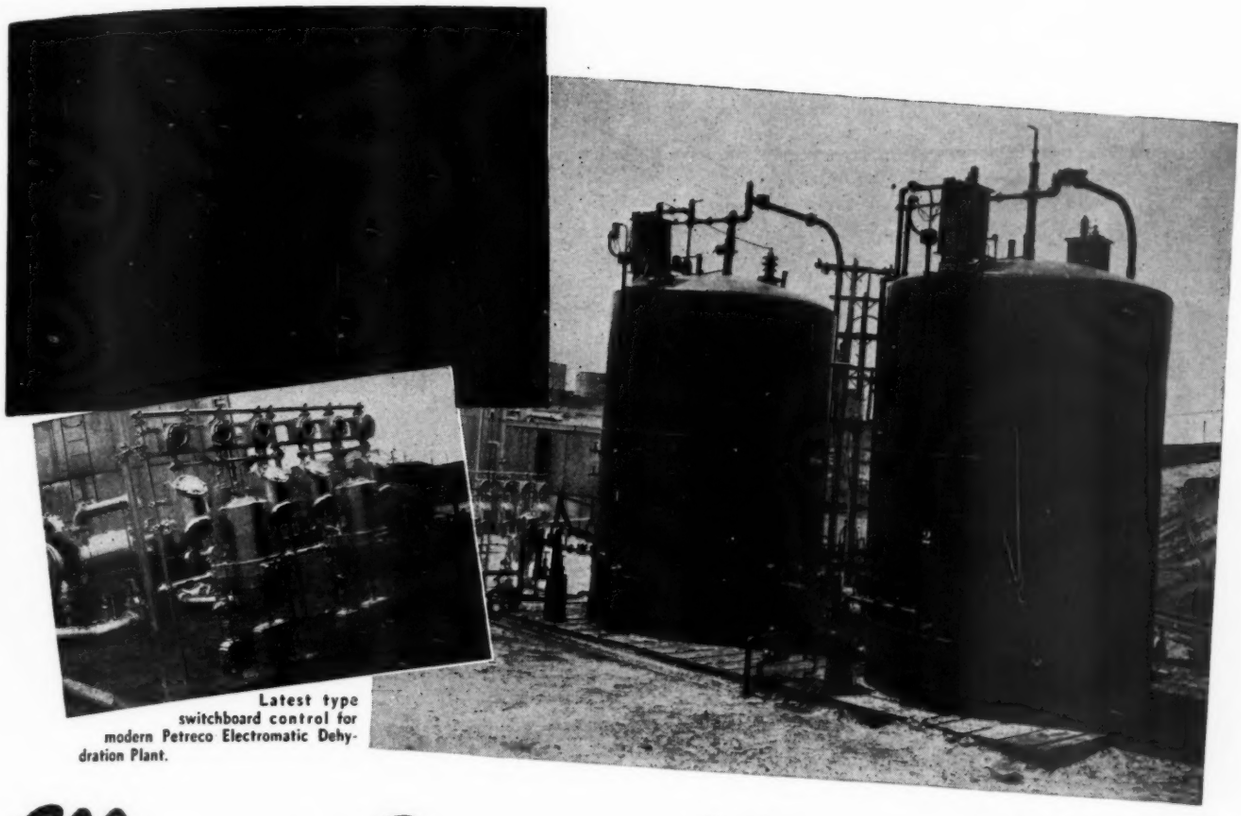

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The Course of Oil

By K. C. SCLATER

New Legal Well-Spacing Principles

Two important papers on the legal aspects of well spacing were delivered before the Mineral Law Section of the American Bar Association at Cleveland, Ohio, last month. James A. Veazey, vice-president and general counsel of the Carter Oil Company, advanced significant new legal concepts of this problem. He said, "That neither one nor a small group of operators in an oil pool can control the spacing of wells therein; that the other operators who wish to space their wells widely have a constitutional position which a legislature, through a police measure regulating spacing reasonably adjusted to the situation of the two groups, may compose and adjust. All that is needed is that the act of the legislature and any adjustment order made there shall not be arbitrary or unreasonable."

In outlining the constitutional principles involved it was pointed out that "Heretofore, we have advanced two principles. The first is to the effect that a state legislature, to protect and encourage a highly essential industry, may provide for the statutory spacing of wells and the pooling of adjacent tracts to accomplish that purpose. The second is that the same objectives might be reached under the doctrines of correlative rights."

On reconciling recovery with size of the spacing unit he said that "This brings us to the point which has been a matter of concern to petroleum engineers and oil lawyers for some years, namely, the balancing of the question of recovery with the size of the spacing unit. In approaching a discussion of this question, the enactment of an enlightened proration statute is assumed; allowables are not to be determined either on a per-well or on a potential basis, but upon the foundation of all of the factors which the latest engineering opinion will support. In these circumstances, all that constitutional law requires is a fair approximation between recovery from a particular pool and the requirement that one well only shall be drilled on that tract. This covers the question of statutory well spacing."

"Then arises the constitutional aspects of pooling adjacent tracts. Assuming a well-considered and reasonable allocation formula established by statute, the situation comes to this: The person having the right to drill a parcel within an established unit may do so, his allowable, however, to be reduced on a basis that will be fair between him and the person having one well on a unit. He should be given the alternative right to participate in the production from the one well drilled on the unit, of which he owns a parcel, by sharing the cost correspondingly. Having the primary right to drill, with his allowable reduced on a reasonable basis for the protection of the whole scheme of well spacing, that alone would withstand the test of arbitrary and unreasonable legislative action. Having the alternative right to share in the production of the permitted well on a reasonable basis, the case again is fortified. All that has been said assumes that the royalty owners, not on a strict acreage basis but under a standard reasonably established by the legislature, shall share in the production of all wells on the unit.

In conclusion Veazey stated "The profit motive must control the business of producing oil, as it does every other enterprise. Even a measurably intelligent self-interest should indicate to the oil producers of America that the drilling of unnecessary wells is an economic crime. * * * Unless sanity, through co-operation in the industry, returns, every important oil-producing state should have a statute under which proper well spacing may be enforced and under which small tracts in any spacing unit may be pooled on the basis of participating in the production from the unit."

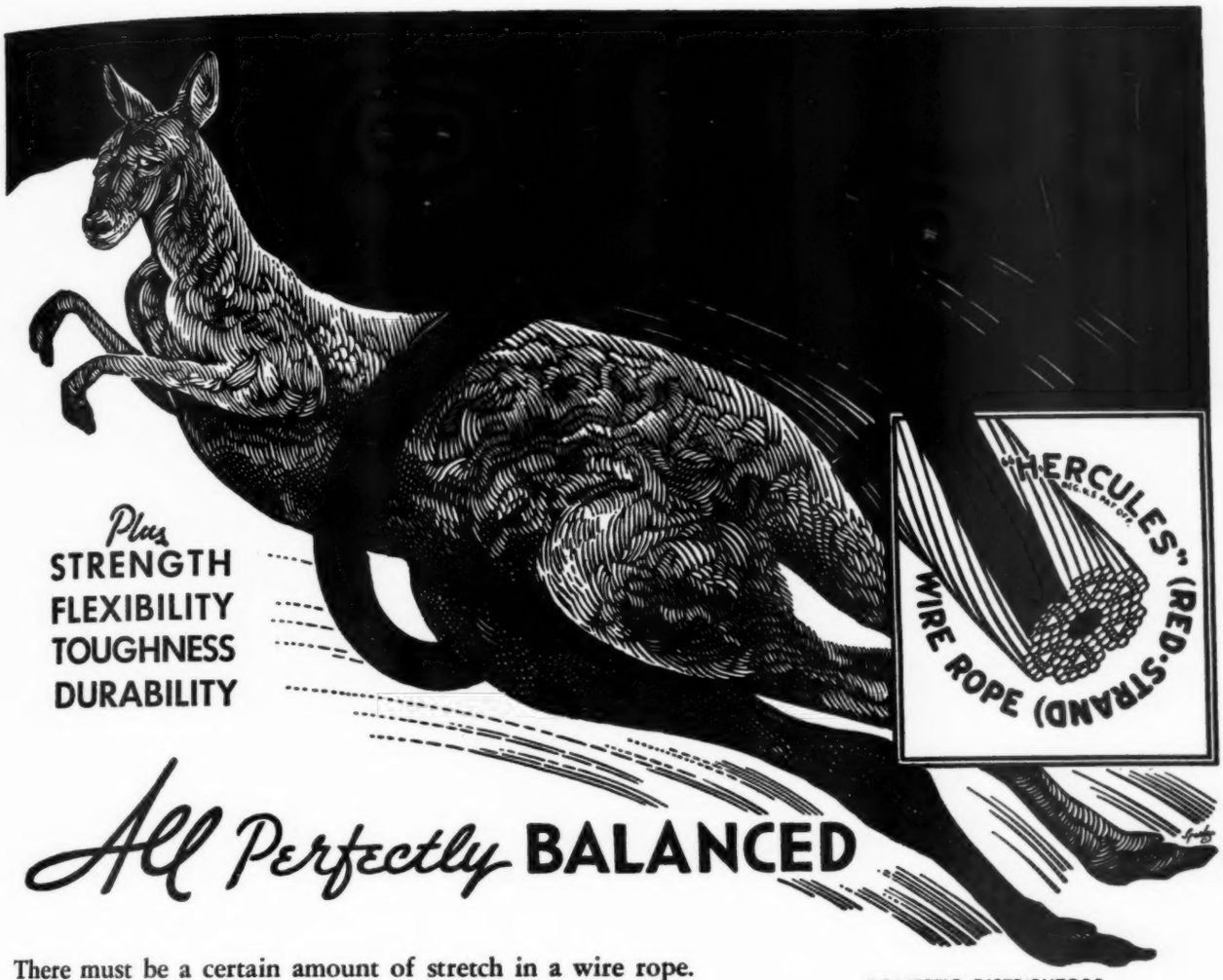
The Problem of the Small Tract

The other paper referred to, by A. W. Walker, Jr., Professor of Oil and Gas Law at the University of Texas, was concerned with the problem of the small tract under spacing regulations. In discussing the interrelated problems he said: "It is obvious that there is no correlation between the number of wells drilled and the amount of oil consumed; nor, under proration, does the drilling of new wells increase the total amount of oil produced. Therefore, so long as the drilling of new producing wells proceeds more rapidly than increases in consumption, and, hence, of production, it is inevitable that we must face the prospect of constantly diminishing well allowables."

In his opinion "The biggest problem in the oil industry, therefore, at the present time is not the existence of too much oil but rather of too many wells."

Regarding unnecessary wells, he said that "The determination of what constitutes an unnecessary well is a highly controversial subject with reference to which there is a great diversity of opinion. Unnecessary wells undoubtedly fall within two categories. Wells drilled in strict compliance with spacing regulations may in fact be unnecessary wells if a smaller number of wells drilled under a wider spacing pattern would have been adequate to efficiently produce the oil from a particular reservoir."

In dealing with the small tract he favored the plan adopted by the legislatures of the states of New Mexico, Oklahoma, and Louisiana. "The small tract which cannot meet the requirements of the spacing rule is denied a well. In order to prevent the confiscation of the oil beneath the small tract, a provision is made whereby the small tract may be pooled with adjacent tracts and share in the production from those tracts upon an equitable basis."



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« « HIGHLIGHTS IN OILDOM » »

Anti-trust Cases to Be Retried September 26

The government's retrial of 18 oil companies and oil executives charged with price fixing has been set for September 26 by Judge Patrick T. Stone. The 18 defendants were among 16 oil companies and 30 of their executives convicted by a jury on January 22 at Madison, Wisconsin, of conspiring to raise and fix gasoline prices in violation of the anti-trust laws.

Judge Stone took under advisement a government motion to rescind that part of his July 19th order in which he granted outright dismissal to 11 of the convicted defendants. He upheld the jury verdict as to 12 major oil companies and five executives and fined them a total of $65,000 and costs.

Retrial of the 18 defendants whose jury conviction was set aside by the court on July 19th indicated that trial of the nine individuals and eight companies accused in a second indictment of combining unlawfully to restrict gasoline jobbers' margins would be delayed.

●

20-Acre Spacing for Two Gulf Coast Pools

The Texas Railroad Commission has adopted 20-acre spacing patterns for the Hamman field, Matagorda County, and the Kubela field, Wharton County. In both fields the commission has ordered a proration formula of 50 percent on a per-well basis and 50 percent on acreage. The order also restricts drilling methods and equipment for the purpose of safeguarding against blowouts. A gas-oil ratio of 2000 cu. ft. per bbl. was ordered for the Kubela field.

●

Protest Trade Agreement With Venezuela

The pending reciprocal trade agreement with Venezuela is being protested vigorously by petroleum interests in the United States. Russell B. Brown, general counsel for the Independent Petroleum Association of America, has presented to the committee on reciprocity information a statement supporting the present excise taxes on petroleum imports and opposing any reduction of them in the negotiations of a trade agreement.

Mr. Brown's statement reads in part as follows:

"This trade agreement, so far as concessions by the United States are proposed, is primarily concerned with petroleum. Exclusive of petroleum and certain items already on the free list, only three percent of the total value of our present imports from Venezuela are listed for tariff negotiations. Approximately 50 percent of the current oil imports from Venezuela are controlled and imported by a single American company. The present excise tax on petroleum products has been one of the bases on which the oil-producing states have built a conservation program which has stimulated exploratory work, increased employment and purchasing power, added to the nation's oil reserves, prevented monopoly, encouraged competition, and added substantial amounts to the revenues of local communities, states, and the federal government."

Brown pointed out that the conservation policies developed by the states in coöperation with the federal government would be seriously handicapped by a reduction in excise taxes, encouraging increased importations of petroleum.

The Oil Producers Agency of California also has issued a statement, through its executive vice-president, Rush M. Blodget, saying that if oil from Venezuela is permitted to enter the United States duty free, which is possible if the trade agreement is reached, it will be virtually impossible for producers of California oil, particularly of the lower grades of crude, to compete with the Venezuelan product in the Atlantic Coast market, which may result in many California producing areas being forced into complete shutdowns, with the consequent loss of employment of all field crews now working in those areas.

●

Production in Germany Shows Increase

Increased drilling throughout Germany has resulted in increased production compared with a year ago. Production in the Bremen district, however, declined 10,318 bbl. during April compared with March, but compared with April, 1937, production showed an increase of 53,396 bbl., about 24 percent.

Oil production in the Hannover district increased 130,998 bbl. the first four months of the current year compared with the first four months of 1937. In the Hannover area the Nienhagen-Hänigsen fields were the only ones to show an increase in production. Having a production of 145,005 bbl., they showed an increase of 20 percent. Production in the Wietze-Steinförde and Eddesse-Oberg fields showed a decrease of four percent and seven percent, respectively.

Total production of mineral oil in Germany during the first four months of 1938 amounted to 1,237,530 bbl. as compared with 1,023,006 bbl. during the first four months of last year, an increase of approximately 21 percent. Hannover fields accounted for 84 percent of the total production, as compared with 89 percent during the first four months of 1937.

●

Nicaragua Grants Oil Concession

The Nicaraguan official bulletin "La Gaceta" recently contained the text of a contract between the Ministry of Public Works and Carlos A. Castro Wassmer, granting the latter the right to undertake explorations in the Republic during a period of three years for hydrocarbons and their derivatives, including natural gas. Exploitation may be undertaken only after the concessionaire has presented evidence of his having spent a minimum of $25,000 in geological investigations and surveys.

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Tidelands Ownership Fight Continues

A strong feeling that the federal government may continue at the next session of congress its efforts to obtain title to California tidelands and to establish title to minerals underlying Spanish land grants, together with the possibility that mineral titles in the "withdrawal" lands in Kern County will be questioned, have resulted in the incorporation on a permanent basis of the United Landowners Association, Inc. This association is the outgrowth of the emergency organization, California Tidelands Association, which sent a delegation to Washington to oppose passage of the Nye resolution in the last session of congress, the Nye resolution being an act that directed the attorney general of the United States to institute such steps as were necessary to establish title to California tidelands in the federal government.

Officers and directors of the newly-formed United Landowners Association, Inc., are: Ralph Forch, Wilshire Oil Company, president; O. C. Field, O. C. Field Gasoline Corporation, vice-president; D. T. Staples, Pacific Western Oil Company, secretary; H. J. March, Signal Oil and Gas Company, director; L. L. Aubert, Bankline Oil Company, director; Wm. C. Whaley, Barnsdall Oil Company, director; Ernest E. Pyles, Hancock Oil Company, director; Ashley Dewitt, Severns Drilling Company, director; L. A. Cranson, Honolulu Oil Corporation, director, and W. D. Inskeep, assistant secretary.

According to Forch, the association will "oppose the efforts of the federal government to establish ownership of any of the three types of titles now apparently to be questioned, in spite of the fact that these titles have been held sound for periods of as long as 90 years. The association knows that the battle is not one for the oil industry alone, but also is of the gravest importance to all natural resource industries, as well as all landowners in general. For that reason, the association will include in its membership many more industries than the oil industry, even though at present the oil industry is the most completely represented."

●

Federal Court Upholds Texas Gas Law

A Federal Court at Austin has upheld the validity of the state law, under which the commission's sour gas order was entered, empowering the Texas Railroad Commission to prevent gas drainage across lease lines, and the order itself was upheld pending further trial of the formula used in the order. The opinion was given in the F. C. Henderson Company case.

In making its decision the court found that Henderson had failed to show that the order was discriminatory. As the order is regarded as a test for other gas proration orders, and is the first order written satisfactory to a federal court, the opinion is significant.

This is the first time the lower federal court has recognized the commission's right to employ the drainage factor in a proration order.

This case affects the sour gas area in the Panhandle, and not the sweet gas area.

Interstate Compact Commission Meeting

Harmony characterized the meeting of the Interstate Oil Compact Commission held in Colorado Springs, Colorado, the latter part of July. Matters of vital interest to the industry as a whole were discussed, and the objections to the compact's work, which caused Governor Huxman of Kansas to threaten withdrawal of that state's representation, were not mentioned. In fact, Judge E. R. Sloan, chairman of the Kansas Corporation Commission and Kansas' representative on the compact commission, supported the motion by Governor Marland of Oklahoma looking to its continuance.

The Marland motion, unanimously adopted, provides for a meeting of the governors or their representatives of the six states now members of the compact commission to consider possible changes in a new compact to replace the existing one when it expires. This meeting will be held in Tulsa, Oklahoma, the date to be determined.

Whether the compact commission should have broader powers and be a more direct factor in the application of conservation regulations was discussed, some favoring and some opposing the proposal. The executive committee of the Independent Petroleum Association of America, favoring more power for the commission, stated in a report:

"The oil states compact is proving of great value to the conservation program of the nation. We recognize the limitations under which it is now operating and would recommend that this compact upon its expiration should be renewed and that its provisions be added to and strengthened by granting authority for this body to make proper allocations of the market demand between the oil producing states of the nation, and authority be given to prevent waste based on market demand.

"Notwithstanding the constructive work that has been accomplished and can be accomplished by the Interstate Oil Compact with only six oil producing states as members, it is essential, if the compact is to perform its function most effectively, that all oil producing states should become members of the compact and we urge that every reasonable effort be made to accomplish this end."

Those opposing an extension of the compact's powers expressed themselves as feeling that it would be impossible to obtain federal and state support of a commission except on its present basis of acting in an advisory capacity, matters of regulation being left to the states.

●

Increase in Austria's Crude Output

Production of crude oil in Austria in May totaled 4900 metric tons, an increase compared with May, 1937, when 3930 metric tons was produced, according to a report to the Department of Commerce by the office of the American trade commissioner at Vienna.

Crude oil production the first five months of 1938 was 21,600 metric tons compared with 13,930 metric tons for the corresponding period of last year.

At present 11 wells are producing in the Zisterdorf territory. One well began producing June 9 of this year, having a daily output of 20 metric tons, and four wells are now being drilled.

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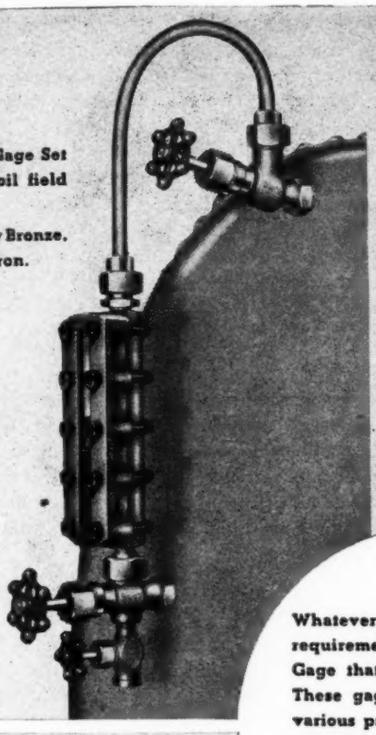

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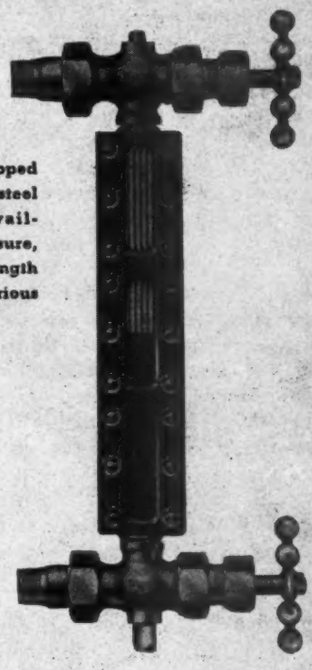

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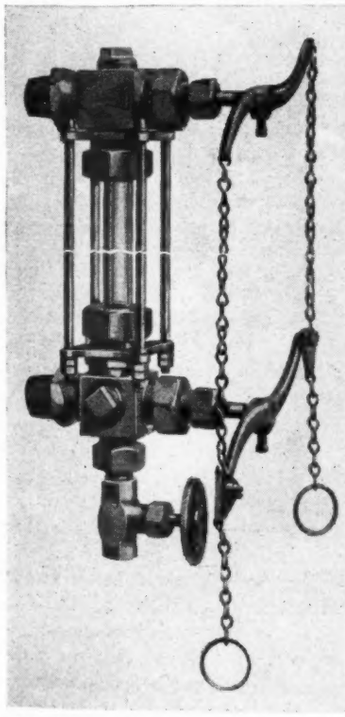
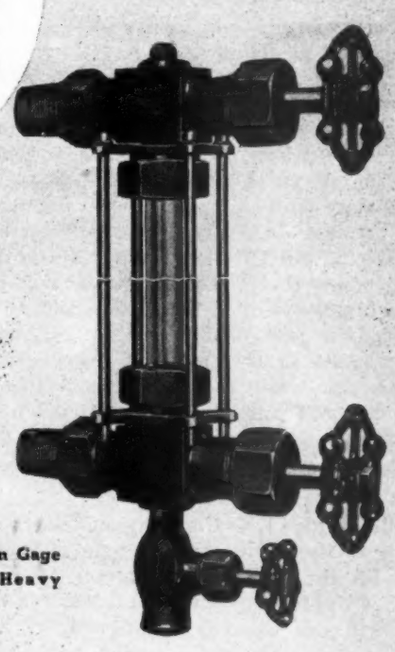


Navy Type Gage
Extra Heavy Bronze



All Iron Gage
Extra Heavy

PENBERTHY INJECTOR COMPANY

Manufacturers of QUALITY PRODUCTS Since 1886
DETROIT, MICH. • Canadian Plant, Windsor, Ont.

Progress of Major Pipe Line Work

PLANS for a $2,000,000 pipe line construction project were completed the latter part of July by officials of the Continental Oil Company, who announced that contracts were awarded for the laying of a line from Lance Creek, Wyoming, to Denver, Colorado, and that contracts will be signed shortly for a line from Lance Creek to Glenrock, Wyoming. Continental has a refinery at the latter point and one at Denver, and is a major crude oil producer in the Lance Creek field.

The Lance Creek-Denver project will be constructed in two units. The S. D. Bechtel Company has been awarded the contract for laying an 8-in. line from Lance Creek to Cheyenne, a distance of 136 miles, and the Osage Construction Company has been given the contract to lay 96 miles of 6-in. from Cheyenne to Denver. A 232-mile telephone line will be strung parallel to the pipe line. The Lance Creek-Glenrock project will include 50 miles of 4-in. line and 15 miles of 6-in., in addition to pump stations and storage terminals.

"This is the largest pipe line construction project announced this year," said Dan Moran, president of the Continental Oil Company, "and it should be a boon to employment, railroad shipments, and business in general throughout the Rocky Mountain area. Approximately $350,000 will be spent for labor, and local labor will be employed. More than 15,000 tons of pipe will be used in building these lines, which means that western railroads will transport about 430 freight carloads, the equivalent of six trainloads of pipe. Besides, there will be another trainload of tank steel, pumps, and other operating equipment."

Construction work began the early part of the month and it is expected that three months will be required to complete the job. Work began at Lance Creek and Cheyenne, and both contractors on the Lance Creek-Denver units are building toward Denver.

●

A natural gas pipe line from southwestern Kansas fields to the Mesabi Iron Range in northern Minnesota is proposed by a group represented by Allen V. Junkin, St. Paul attorney, who states that a $20,000,000 Reconstruction Finance Corporation loan will be sought to finance the project. The application for the loan has been drawn in the name of the Kansas Pipe Line and Gas Company of Chicago. Natural gas would be supplied to communities and industries requesting it along the route of the line, through Nebraska, North and South Dakota, and Minnesota. The National Coal Association is opposing the project on the grounds that it would increase unemployment in the mining area.

A week later John W. Schmidt, Anoka, Minnesota, president of the Public Service Gas Company of Minneapolis, Minnesota, and Great Falls, Montana, announced that his company had made application to the R.F.C. for $50,000,000 to construct a gas line from Wyoming and Montana to Minnesota and Wisconsin.

●

The Illinois Pipe Line Company announces it will lay an 8-in. loop to its existing 6-in. line from Vandalia, Fayette County, Illinois, to a booster station 12 miles south in Marion County, to supplement transportation facilities from the active areas of Clinton, Marion, and Fayette counties.

●

The Memphis Natural Gas Company is adding two 600-hp., 6-cylinder Clark "Angle" compressors to its Guthrie, Louisiana, booster station. The station now contains four twin-tandem, 1250-hp. horizontal units. The new 300-r.p.m. angle units are being added to give the station more flexibility and additional capacity.

●

Although no steps have been taken toward actual construction of pipe line outlets from the Turner Valley field of Canada to Vancouver, British Columbia, and Fort William, Ontario, under consideration for some time, engineers are working on plans for both lines, according to E. W. Kolb, secretary of the Petroleum Producers Association. He states that it will be necessary for the Turner Valley potential to attain a figure considerably greater than the present 51,426 bbl. before the construction of the lines would be practicable. The line to Fort William would be about 1100 miles in length and the one to Vancouver 650 miles. The former would deliver crude oil to lake tankers for shipment to refineries in Ontario and Quebec, and the latter would deliver crude at Vancouver for British Columbia refineries and for export.

●

The Texas Company will lay a nine-mile, 4-in. pipe line from Salem, Illinois, to connect at Sandoval, Illinois, with the Illinois Pipe Line Company's system. The crude will be moved by portable pumping units. The same company is making a right-of-way survey between Salem and Lawrenceville, Illinois, for 55 miles of 8-in. line and 20 miles of 10-inch.

●

O. C. Whitaker, Inc., Fort Worth, Texas, has been awarded a contract by the Carter Oil Company of Illinois to lay nine miles of 6-in. pipe from the company's Brownstown, Illinois, station in Fayette County, northeast to the Loudon area. In addition, six miles of 8-in. are to be laid, joining two systems, to serve the Loudon area.

●

The Union Sulphur Company has awarded a contract to D. A. Swink, Shreveport, Louisiana, to lay 12½ miles of 6-in. pipe from the Woodlawn field, Jefferson Davis Parish, to a tank farm and loading docks at Gillis. The Union Sulphur Company owns the Woodlawn field, having one producing well and one distillate well completed at the present time.

●

Construction of a 280-mile gasoline pipe line from Danges, near St. Nazaire, to Montargis, near Orleans, France, has been decided upon by the Ministry of National Defense. The route of the line will be along the Loire Valley.

●

The Atlantic Refining Company has awarded to the Worthington Pump and Machinery Corporation the contract for the cargo discharge and circulating pumps for a third 18,500-ton welded tanker to be built for The Atlantic Refining Company at the Sun Shipyards, Chester, Pennsylvania. The three 300-hp. discharge pumps will be of the centrifugal, deep-well type, driven by 2300-volt explosion-proof motors. Combined capacity will be 630,000 gal. per hour, making it possible for the vessel to unload cargo in approximately 11 hours, about one-third the usual discharge time for a vessel of this size. The main and auxiliary circulating pumps will have a capacity of 522,000 gal. per hour.

Here are 3 REASONS why I choose COOK'S RINGS!

"**MATERIAL**—I've found that COOK'S Rings quickly develop a work hardened skin which keeps down cylinder wear and makes the rings last. I'm told it's the excess primary graphite in COOK'S GRAPHITIC IRON and the absence of free carbides in this special material that does it. But whatever it is, COOK'S Rings certainly do retard my cylinder wear and they do stand up.

"**MORE POWER**—I've learned from experience that you can't use just plain compression rings alone. There's a loss of power through the joint openings of all of them — and it gets worse with ring and cylinder wear. There's only one way to avoid that loss — use dependable two-piece sealing rings. I use COOKTITES because they seal my pistons 100% and they're engineered to do a good job even in badly worn cylinders. According to the amount of cylinder wear, they give me from 10 to 25% more power with a corresponding saving in fuel—And let me tell you—**they are absolutely dependable.**

"**COOK'S STABILITY** — Cook never goes off half-cocked in the face of the many new ring theories that come and go. It's their 50 years experience, I guess, that accounts for their stability. They know their combination of COOK'S GRAPHITIC IRON Plain Rings and COOKTITE Sealing Rings is right and they stick to it. I know they are right too, because I've tried them all. You can't beat COOK'S Rings."

●

This typical user makes out a strong case for COOK'S Rings. But there are many more reasons why they never fail to improve performance and cut costs. Write for complete information.

COOK'S GRAPHITIC IRON PISTON RINGS

SEALING PRESSURES SINCE 1888

50th ANNIVERSARY

C. LEE COOK MANUFACTURING CO.

INCORPORATED

New York Cleveland Los Angeles Baltimore LOUISVILLE, KY. Chicago Tulsa New Orleans San Francisco

Latest Activities In The Oil Fields

J. M. Huber Corporation's No. 1 H. & M., one-half mile south of the Lance Creek field, Wyoming, produced oil at the rate of 2600 bbl. per day from the Leo sand. More significant than the extension of the field is the fact that the production of this well far exceeds that of any other well completed in the Leo sand, indicating the possibility that the productive portion of the Leo sand may extend considerably farther south.

●

Magnolia Petroleum Company's No. 1 Valadez Heirs, in La Anima Sola Grant, Jim Wells County, Texas, 15 miles southwest of Alice and near the Duval County line, produced dry gas from the Jackson sand at a depth of 6408 to 6415½ feet. Casing was set at a depth of 6408 ft. and total depth is 6419 feet. Closed-in tubing pressure was 3550 lb. and casing pressure 3635 pounds.

●

Rhodes and Tompkins et al's No. 1 Emma Cowden, in section 1, block 44, T-2-n, T. & P. Survey, Andrews County, Texas, produced 1060 bbl. of oil per day from a depth of 4160 to 4222 feet. The producing formation was treated with a total of 6500 gal. of acid.

●

Young and Newsome's No. 1 Edgeman, in SE SE SE 17-7n-6e, Seminole County, Oklahoma, about two miles west of the Little River pool, produced 293 bbl. of oil in 11 hours from the Wilcox sand at a depth of 4380 feet. Gravity of the oil is about 40 deg. A.P.I. The 7-in. casing was set at a depth of 4262 feet.

●

Indian States Oil Company's No. 1 Bailey, in NW NW NE 2-12-5e, Lincoln County, Oklahoma, swabbed seven bbl. of oil per hour from Hunton lime at a depth of 4238 feet. The volume of gas accompanying the oil was estimated to be 250,000 cu. ft. per day. The well was treated with 5000 gal. of acid. The well extends the Wilzetta pool southward and may indicate a connection with the South Wilzetta pool.

Atlantic Refining Company's No. 1 McCurry, in NW NE SW 6-6n-4e, Pottawatomie County, Oklahoma, between the Asher pool and the St. Louis area and two miles from the nearest producing well, flowed 100 bbl. of oil by heads in six hours, from Viola lime at a depth of 4209½ feet. The 7-in. casing was set at a depth of 4189 feet.

●

The Texas Company's No. 2-D State, in 27-17s-34e, Lea County, New Mexico, extended the Vacuum field one mile west when it swabbed 32 bbl. of oil from a depth of 4860 feet. The well was treated with 1000 gal. of acid, then after a 420-qt. shot was re-treated with 2000 gal. and 3000 gal. of acid.

●

Pryor and Lockhart et al's No. 1 Gant "C", in NE NE NE 18-31s-13w, Barber County, Kansas, opened a new field and a new producing formation for the county when it filled 1500 ft. with oil in three hours from the Arbuckle limestone and dolomite at a depth of 4607 to 4610 feet. The well is cased with 5-in. casing. The operators regarded a show of gas in the Viola limestone and oil in the Wilcox sand as insufficient for commercial production.

●

Crown Petroleum Corporation et al's No. 1 Wolf Estate, in SE SW SE 36-19s-12w, Barton County, Kansas, one and one-half miles northwest of the West Ellinwood pool, filled 2200 ft. with oil in 22 hours from the Arbuckle dolomite at a depth of 3348 to 3374 feet.

●

Stonewall Oil Company's No. 1 H. T. Carlile, in section 293-D, H. & T. C. R. R. Survey, Stonewall County, Texas, five miles north of Peacock and in the extreme northwestern part of the county, flowed 365 bbl. of oil in 14 hours from the Palo Pinto limestone at a depth of 5169 to 5176 ft. after experimental treatment with 500 gal. of acid. On a subsequent 12-hour gauge the production averaged 9.34 bbl. per hour.

AVERAGE CRUDE PRICES

California		Louisiana	
Kettleman Hills	$1.19-1.43	Rodessa	$ .91-1.25
Playa Del Rey	.80-1.16	Gulf Coast	.84-1.41
Coalinga	.70- .90	North Louisiana	.90-1.22
Signal Hill	.80-1.21	Illinois	1.35
Montana	1.35	Kentucky	1.30
Wyoming	.97-1.30	Indiana	1.12
Colorado	1.12-1.18	Ohio	
New Mexico	.78-1.08	Lima	1.00
Texas		Michigan	1.27
North Central	.96-1.20	Pennsylvania	
Panhandle	.91-1.08	Bradford	1.80
West Texas	.78-1.08	Southwest	1.46
Gulf Coast	.95-1.41	Eureka	1.40
Darst Creek	1.09	Buckeye	1.30
East Texas	1.35	Corning	1.17
Talco	.73	West Virginia	1.67
Kansas	.98-1.30	Canada	2.10-2.17
Oklahoma	.98-1.30		
Arkansas	.90		

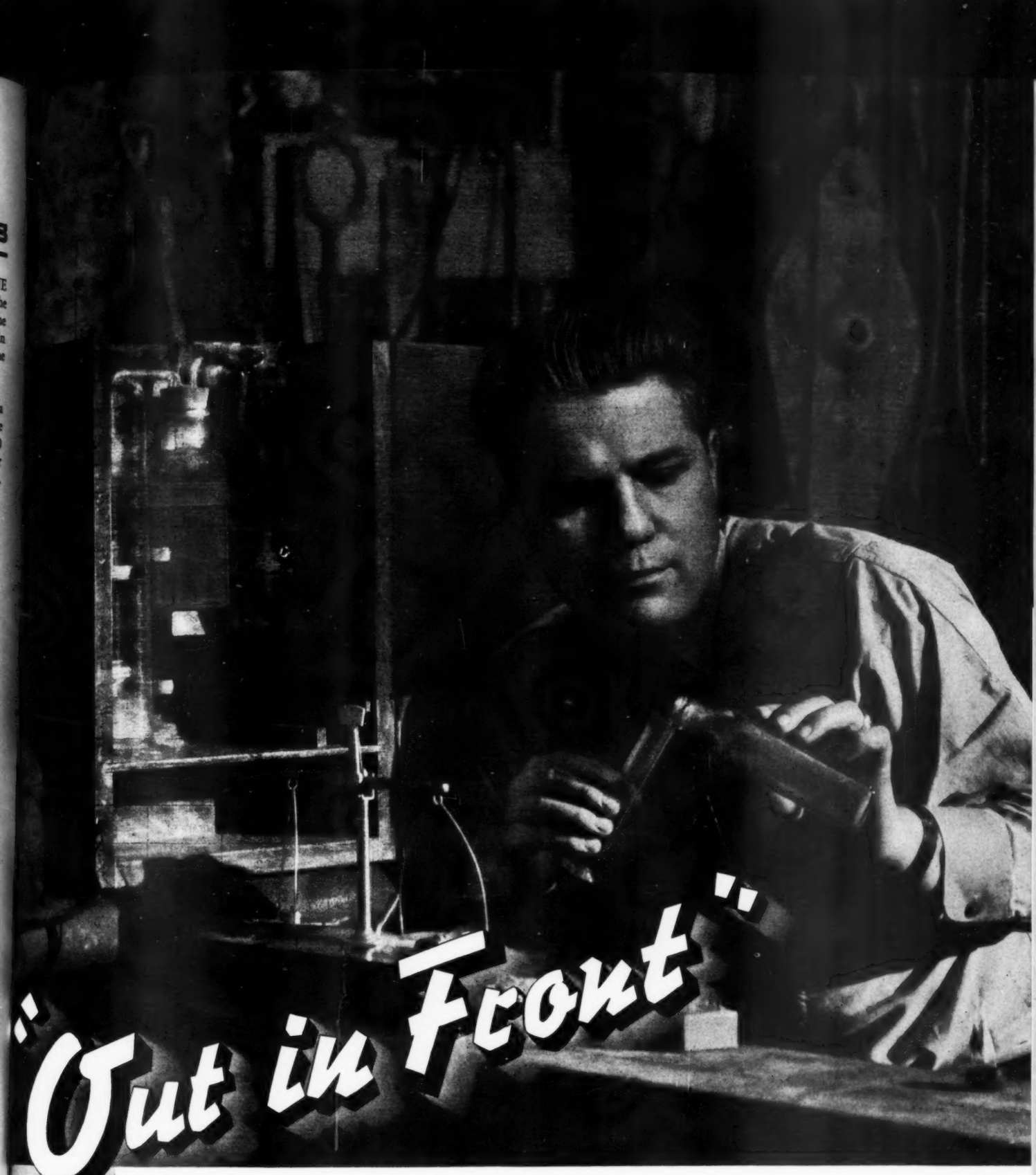
DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in Barrels)

	[1]B. of M. Dept. of Int. Calculations (July)	Week Ended July 30, 1938	Week Ended July 2, 1938	Week Ended July 31, 1937
Oklahoma	518,400	422,600	376,550	637,650
Kansas	172,300	154,000	143,150	207,150
Panhandle Texas	.....	72,350	64,300	80,950
North Texas	.....	78,600	73,200	73,200
West Central Texas	.....	29,200	28,400	33,600
West Texas	.....	218,700	181,750	205,950
East Central Texas	.....	100,400	88,300	125,300
East Texas	.....	439,600	364,300	470,800
Southwest Texas	.....	239,900	203,850	238,700
Coastal Texas	.....	213,400	188,350	204,500
TOTAL TEXAS	1,360,300	1,392,150	1,192,450	1,433,000
North Louisiana	.....	82,500	79,400	91,850
Coastal Louisiana	.....	186,950	184,250	172,200
TOTAL LA.	260,600	269,450	263,650	264,050
Arkansas	51 000	57,100	51,100	28,700
Eastern	149,700	142,400	145,400	122,200
Michigan	56,400	51,100	53,450	45,100
Wyoming	55,500	58,000	61,100	56,700
Montana	13,500	13,850	13,650	18,300
Colorado	5,200	3,700	3,750	5,000
New Mexico	112,900	101,350	91,200	114,450
TOTAL EAST OF CALIF.	2,755,800	2,665,700	2,395,450	2,932,300
California	642,300	650,700	663,100	659,600
TOTAL U. S.	3,398,100	3,316,400	3,058,550	3,591,900

[1]These are Bureau of Mines' calculations of the demand for domestic crude oil based upon certain premises outlined in its detailed forecast for the month of July. As demand may be supplied either from stocks or from new production, contemplated withdrawals from crude oil stocks must be deducted from the Bureau's estimate of demand to determine the amount of new crude oil to be produced.



OUT IN FRONT . . . with Individualized Treatments

There is no mystery about acidizing. How it works and why, is easy to understand.

But, the more you understand it, the quicker you realize it takes genuine experience and a broad technique to make it give maximum results.

Dowell has spent over six years developing and expanding the process of acidizing. And yet, for all this experience, it still recognizes the importance of specialized study.

For example, to get the low-down right on the job, Dowell frequently sends a technician to the well to learn exact conditions before treatment.

Only with *all* the facts in hand can an intelligent and productive treatment be given. Dowell is definitely "out in front" with the majority of producers because it offers a service that is adapted to the specific conditions of every well.

NEW! DOWELL "XR" ACID

The Sustained Action Acid

Dowell's latest achievement—a new principle of acid action. Dowell "XR" Acid is kept active till it travels far into the pay zone. Get the facts on Dowell "XR." Information at all Dowell stations.

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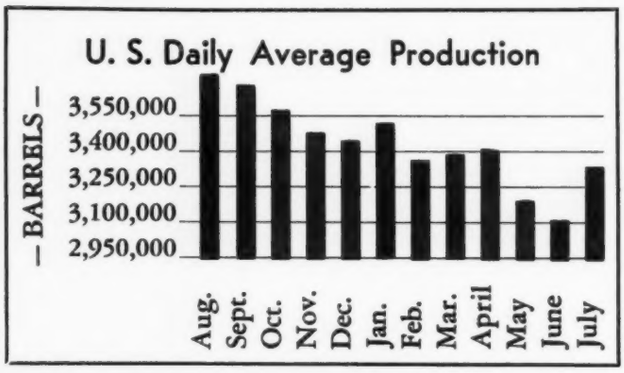
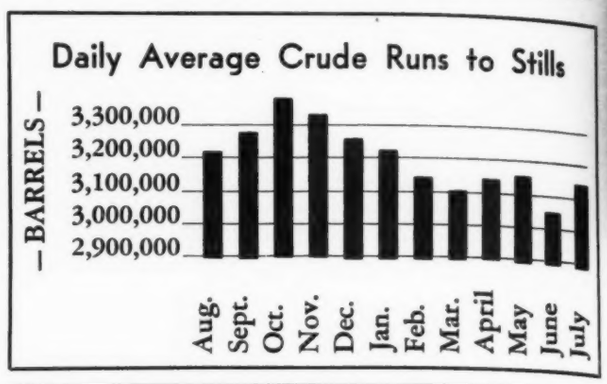
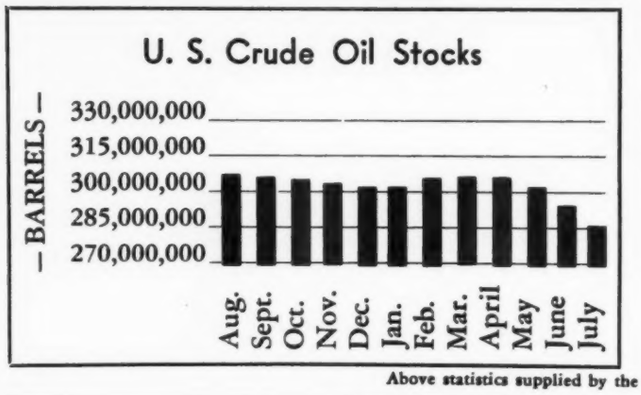
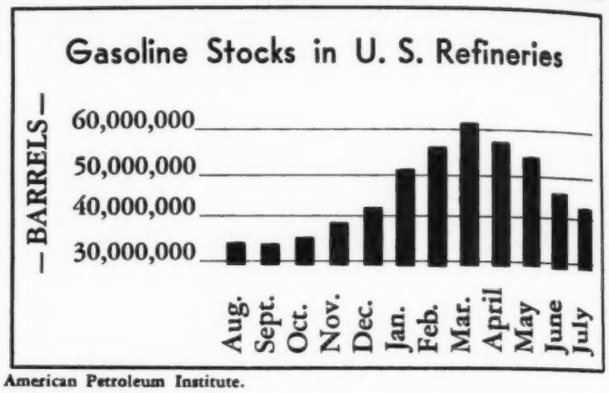
OIL AND GAS WELL CHEMICAL SERVICE

Summary of Petroleum Statistics and Field Activities









Above statistics supplied by the American Petroleum Institute.

Summarized Operations in Active Fields for July, 1938

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	147	144	30	93	3500-3700	2	40	Rotary
Duval County	46	30	6	18	1554-2900	2	22	Rotary
Ector County	55	54	21	81	3675-4377	2 and 3	32-36	Rot.-Cab.
Panhandle	42	41	38	135	1700-3900	2	40	Rotary
Refugio County	20	18	3	12	4900-5900	2	38	Rotary
Nueces County	35	29	8	29	3922-5878	2 or 3	21-54	Rotary
Winkler County	22	22	7	7	2850-3450	2 and 3	30-38	Rot.-Cab.
Talco Field	6	6	1	3	4230-4361	2	16-24	Rotary
K. M. A. Field	100	97	57	117	3730-3935	2	42-43	Rot.-Cab.
OKLAHOMA								
Oklahoma City	6	5	2	9	6450-6682	3	39	Rotary
Fitts Pool	20	17	2	8	1800-4488	2 or 3	38	Rotary
KANSAS								
Russell County	10	7	3	19	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	14	12	2	17	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	18	14	3	17	3290-3518	2	39-42	Rot.-Cab.
LOUISIANA-TEXAS-ARKANSAS								
Rodessa	14	14	2	14	5950-6450	3	39	Rotary
ILLINOIS								
Central Illinois	193	149	20	224	2950-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	26	25	15	79	3150-4030	3	30-34	Rot.-Cab.
CALIFORNIA								
Kettleman Hills	4	4	2	11	8300-8730	3 or 4	40	Rotary
Wilmington	24	24	15	29	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for July, 1938

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1937 (In Barrels)
	July	June	July	June	July	June	July	June	July	June	
Arkansas	16	22	16	19	37	43	22	19	43	38	12,088,341
California	118	126	106	104	107	93	85	105	219	220	238,587,663
Colorado	....	1	....	0	....	....	1	1	27	20	1,532,893
Illinois	193	192	149	147	....	....	175	**174	75	74	7,376,022
Indiana	15	9	8	6	....	....	2	2	30	25	820,000
Kansas	116	150	76	117	128	125	28	30	189	191	70,542,000
Kentucky	83	67	56	45	....	....	10	15	99	81	5,500,000
Louisiana	93	124	70	98	151	157	57	52	219	225	90,501,068
Michigan	78	89	49	65	81	75	26	25	132	141	16,254,181
Mississippi	1	2	0	0	....	....	3	2	3	4	Gas Prod.
Montana	9	2	9	2	....	....	3	3	52	54	5,775,000
New Mexico	32	52	28	49	....	....	12	14	150	159	38,642,184
New York	43*	14	32	14	....	....	....	....	....	....	5,466,200
Ohio	91	89	63	57	....	....	45	49	125	129	3,547,600
Oklahoma	197	211	113	144	195	154	36	34	289	277	225,402,731
Pennsylvania	167*	....	161	....	....	....	....	....	....	....	19,154,400
Texas	1068	1193	831	917	1067	1124	375	399	1245	1392	506,891,233
West Virginia	49	50	40	35	....	....	19	21	99	105	3,833,000
Wyoming	15	9	9	8	....	....	3	5	67	69	19,402,121
Total	2384	2402	1816	1827	1766	1771	902	950	3063	3204	1,271,316,637

*Includes water-intake and pressure wells.
**Includes 38 rigging up and 136 rigs standing.

PRE-FORMED ROPE COSTS *LESS*..

Where Bending Is Severe

Many have postponed a trial of pre-formed rope because it "costs more." But the fact is that when used for the purposes for which it is especially suited, pre-formed rope costs substantially less, in the end, than ordinary construction.

This is because pre-formed rope, being free from internal stresses, is much slower to fatigue under repeated bending,—and because its firmer body better withstands drum crushing. These facts make pre-formed by far the most economical rope for

ROTARY DRILLING LINES — TUBING LINES — SUCKER ROD LINES

Try UNION-formed Rope (our superior pre-formed line), in these services. You'll find — as have hundreds of others — that it brings a substantial reduction in your rope expense.

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IN THE PHOTOGRAPH

The photo shows a Phillips Petroleum Company well near Jefferson, Texas, being drilled by J. I. Roberts Drilling Company. Left to right, the men are: A. P. Stiles, Union Wire Rope Corp.; F. A. Knouse, derrick man; R. P. Wilson, and L. C. Moore, helpers; J. E. Thomas, fireman; J. F. Smith, driller; B. B. Curry, Jarecki Rodessa store.

Union FORMED

UNION WIRE LINES

The "ULTIMATE LOW COST WIRE ROPE"

The Month's Activities in Refining

Percent Refining Capacity Operated

Western Division, 69.3 Percent **Central Division, 77.9 Percent** **Eastern Division, 80.2 Percent**

THE Cargo Oil Company of Texas, of which John Golden is president, has begun the construction of a refinery in the K.M.A. field, Texas. Specifications call for a plant of the pressure tube still type having a capacity of 1500 bbl. per day. High-test gasoline, Diesel fuel, and other products will be manufactured.

The company also has broken ground for a loading rack on the Mangold ranch, near Mankins. A 4-in. line will be laid from the rack to the pool and a 3-in. gathering system will be provided.

●

The Worth Refining Company, Inc., Chicago, Illinois, has completed the erection of a 1500-bbl. refinery at Blue Island, Illinois. Gasoline, kerosene, distillate, fuel oil, and gas oil are being manufactured. Officers of the company are T. F. Thompson, president; George E. Phoenix, vice-president; Leo M. Herker, treasurer, and E. V. Rehberg, secretary.

●

Dr. Sidney Born and William C. Berry have purchased from the receiver, Frank Porter, the 4000-bbl. skimming plant at Ardmore, Oklahoma, owned originally by the Cameron Refining Company and later by the Wirt Franklin Petroleum Corporation. The refinery is to be reconditioned and placed in operation.

●

The Union Oil Company of California and the Superior Oil Company have completed and placed in operation their new absorption-type gasoline plant near Shafter, Kern County, California. Gas supply is from wells in the Rio Bravo field. The plant has a capacity of 20,000,000 cu. ft. of gas per day, although at present it is processing but 5,000,000 cu. feet.

The plant is owned by the two companies jointly but is being operated by the Union Oil Company.

●

B. V. Hole, Cut Bank, Montana, producer, is constructing a topping plant at Spokane, Washington, to operate on Cut Bank crude. The plant will have a capacity of 500 bbl. per day and will manufacture gasoline, distillate, and kerosene.

The lubricating oil plant and auxiliary equipment destroyed at Wellsville, New York, recently, will be rebuilt by the Sinclair Refining Company, it has been announced. Various units in the refinery that were damaged but slightly by the fire already have been reconditioned and returned to operation.

●

The Bechtel-McCone-Parsons Corporation has been given a contract by the Union Oil Company of California for the construction of a new phenol-solvent lubricating oil plant at the company's Oleum refinery on San Francisco Bay. Work has begun.

●

Results obtained by small polymerization units at McClanahan Refineries, Inc., St. Louis, Michigan, and at Leonard Refineries, Inc., Alma, Michigan, demonstrate that the catalytic polymerization process can be successfully adapted to the scale of operations of the small cracking plant.

The McClanahan unit is processing 270,000 cu. ft. of cracked gas per day, produced by the company's 1100-bbl. Dubbs reforming unit. It is producing 2600 gal. of polymer gasoline per day, having an octane rating of 83 and a blending value of 100.

The Leonard polymerization unit was placed in operation June 22 and is still running. It is processing 150,000 to 175,000 cu. ft. of cracked gas per day from the Dubbs 1100-bbl. per day, 2-coil, selective cracking unit. It is producing about 1500 gal. of polymer gasoline per day similar in characteristics to that made by McClanahan.

The difference in yield increase between the McClanahan and the Leonard units is because McClanahan is using the polymerization operation primarily to step up yield, and Leonard is using it primarily to improve octane number.

McClanahan and Leonard took a pioneering step when last spring they signed contracts with Universal Oil Products Company for small U. O. P. polymerization units. Universal was pioneering, too, because all such units previously built had been designed for large volumes of gas and their cost was beyond the pocketbook of the small refiner.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks
Week Ended July 30, 1938

A.P.I. Figures

(Figures in Barrels of 42 Gal. Each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	466,000	69.7	21,313	13,331
Appalachian	88.4	105,000	81.4	3,165	1,108
Ind., Ill., Ky.	92.4	437,000	89.4	12,657	9,361
Okla., Kans., Mo.	84.7	285,000	74.4	6,548	4,252
Inland Texas	56.6	148,000	73.6	2,087	1,876
Texas Gulf	95.7	772,000	96.9	9,945	12,580
La. Gulf	96.6	130,000	77.4	2,444	3,410
No. La. & Ark.	63.7	39,000	67.2	525	826
Rocky Mt.	69.7	44,000	71.0	1,633	881
California	90.9	504,000	67.6	12,667	93,739
Reported	89.0	2,930,000	79.1	72,984	141,364
Estimated Unreported	.....	310,000	.....	3,880	2,930
*EST'D TOTAL U. S. JULY 30, '38	.....	3,240,000	.....	76,864	144,294
*EST'D TOTAL U. S. JULY 23, '38	.....	3,180,000	.....	76,366	143,041
U. S. B. of M. *July 30, '37	.....	**3,380,000	.....	70,504	107,600

*Estimated Bureau of Mines' basis.
**July, 1937, daily average.

THE Petroleum Engineer

AUGUST, 1938

Portable Derrick Facilitates Drilling of Wildcat Wells

Appreciable saving of time and labor effected by use of easily assembled tower

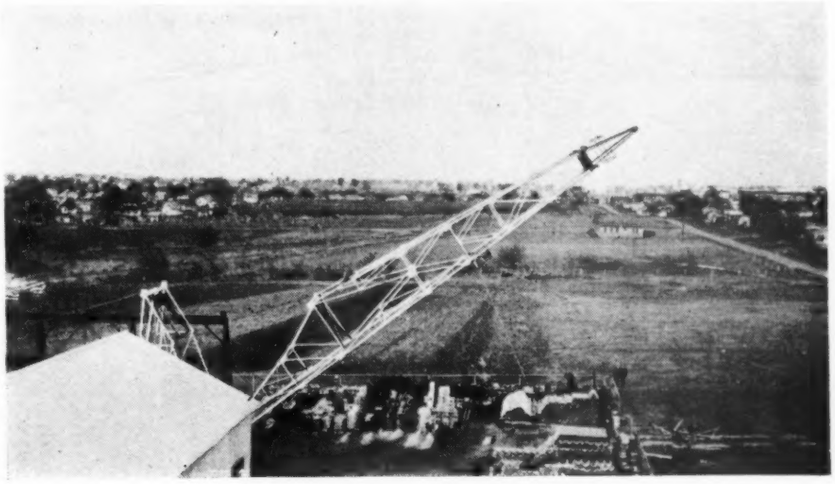
By RALPH H. KING

THE Portable Jackknife Mast recently introduced by Lee C. Moore and Company, Inc., was designed primarily for use in drilling wildcat wells. It resembles an ordinary 90-ft. derrick when erected and has virtually the same capacity, but is readily erected and dismantled by the drilling and trucking crews.

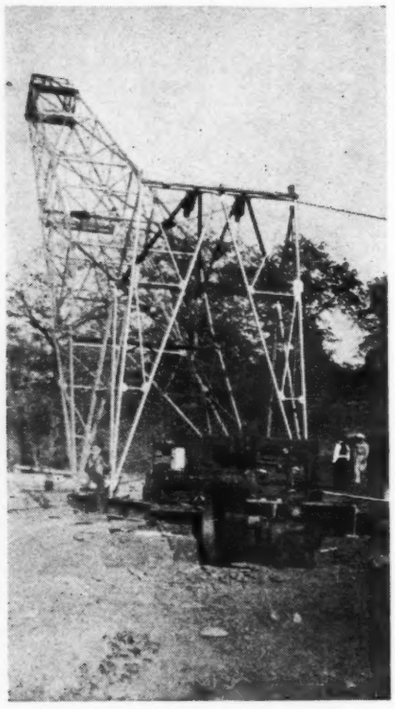
The first derrick of this type is being used by Harry Bass, drilling contractor of Dallas, Texas. It consists of three 28-ft. sections, the total height of the derrick being 84 feet. The upper third of the derrick is made in two pieces, the middle part in four pieces, and the lower third in four pieces. Two pieces of the lower third and all pieces of the middle and upper thirds are assembled on the ground to form the tower. The other two pieces of the lower third are joined and set in place and support the pulley over which is strung the line used to pull the tower into position.

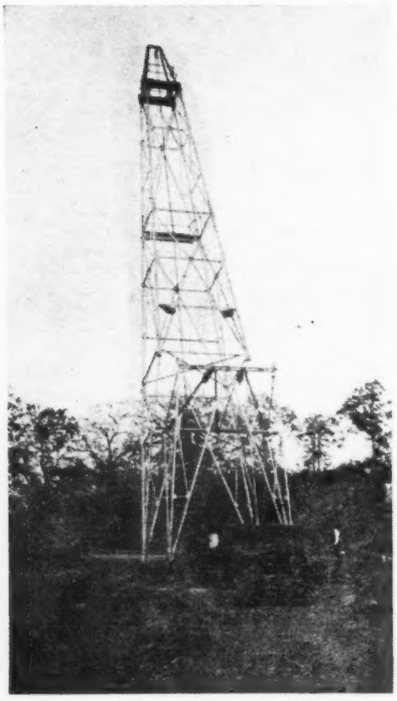
The steel foundation consists of two sections 8 ft. wide and 32 ft. long, connected by webbing. This foundation is set at the well location and the engines and drawworks placed in position. The stationary part of the derrick is then erected over the drawworks and the drilling line is strung through a pulley at the top of the stationary part of the derrick. The base of the tower is pivoted at the end of the foundation, and the drilling line is attached to the top of the tower. By the spooling of the drilling line the tower is drawn into position. All accessories, such as the standpipe, fourble board, finger board, and electric light wires, are put in place while the derrick is on the ground, so that when the tower has been drawn into position it is necessary only to hoist the crown block into place and string the drilling line through the crown and traveling blocks. The entire erection requires about five or five and one-half hours.

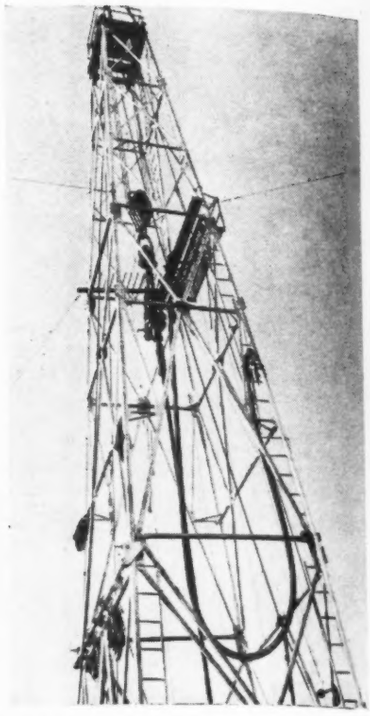
The different pieces of the mast are connected by bolted flanges. A bull plug in the flange of one section fits a socket in the companion flange, hold-



Trial erection at Tulsa plant







Progressive views of tower during and after erection and rigging-up

ing the parts in position while the bolts are being inserted and tightened.

The steel foundation obviates the need for timber sills. A floor of wooden planks is laid on the foundation as the wooden floor is not so slippery as the steel when coated with mud or oil.

The 84-ft. height of the derrick permits the racking of 2-joint stands of drill pipe. About 100 stands of 3-in. drill pipe can be racked, as the derrick floor is 18 ft. 6 in. by 16 ft. 6 inches. As there is room in the derrick for 6000 ft. of 3-in. drill pipe, a 6¾-in. hole can be drilled to a depth of 6000 ft. but 8¾-in. hole requires the use of 4-in. drill pipe and as there is room in the derrick for only about 4000 ft. of 4-in. drill pipe, an 8¾-in. hole could be drilled to a depth of only 4000 feet.

The derrick is designed to support a load of 323,000 lb. and has a safety factor of two. Except when stuck pipe is being pulled the derrick is not likely to be subjected to overload.

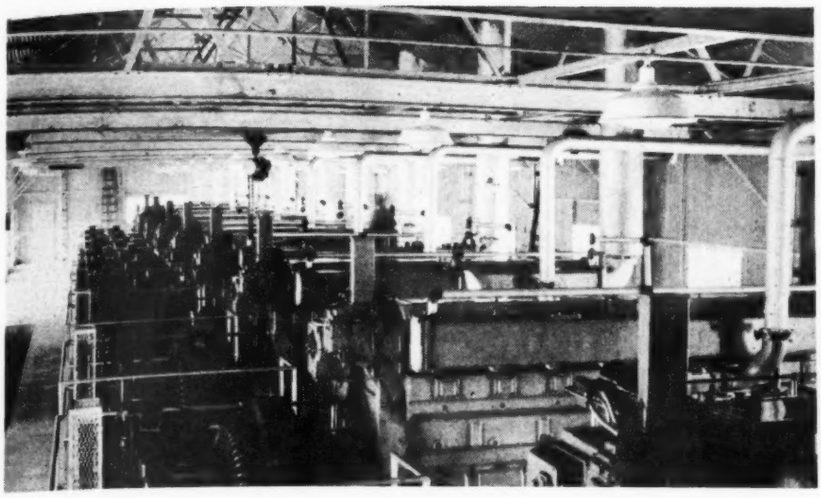
When dismantled the derrick and foundation may be loaded on two trucks as the width of the pieces does not exceed eight ft. and the total weight is about 13,000 pounds. This is important in Texas operations as the highway laws allow a maximum load of only 7000 lb. and a maximum width of eight feet.

The foregoing specifications apply to the first unit built. The height of units built later was increased to 92 ft. and the base to 18 ft. 4 in. by 18 ft. 4 inches.

The derrick described has been used in drilling three wells. The first was a 2500-ft. wildcat well near Drumright, Oklahoma. The second well was drilled in wildcat territory near Pratt, Kansas, to a depth of 4600 feet. A third wildcat well was drilled to a depth of 2600 ft. near Eldorado, Kansas. At each location the derrick was erected in about five hours and dismantled in much less time. If it seemed desirable the entire rig probably could be skidded a short distance as the steel foundation is suitable for a skid. Thus the derrick is almost as well adapted to drilling shallow producing wells as it is to wildcatting.

Experience indicates that the portable mast is as rigid and has room to rack as much drill pipe as the ordinary 90-ft. derrick, but can be erected by the drilling and truck crews at an appreciable saving in money and time. It is much more rigid than the ordinary mast and will accommodate 2-joint stands of drill pipe, but is almost as portable as the mast. Undoubtedly it will be improved and perfected in the future as experience has proved that the portable mast has these definite advantages.

Drawworks, steel base, and a part of the tower.



Interior of E. H. Moore, Inc., generating plant in Fitts Pool, Oklahoma, showing generators and gas engines

By
J. C. ALBRIGHT

Central Plant in Fitts Pool Generates Current for All Phases of Production

Maintenance of a separate account for each current-consuming unit facilitates determination of pumping and servicing costs

IN the latter part of 1936, E. H. Moore, Inc., began construction of a central electric generating station in the Fitts Pool, Pontotoc County, Oklahoma. The power was to be used for pumping wells, for illuminating grounds and buildings, for cleaning wells, and for virtually all other purposes.

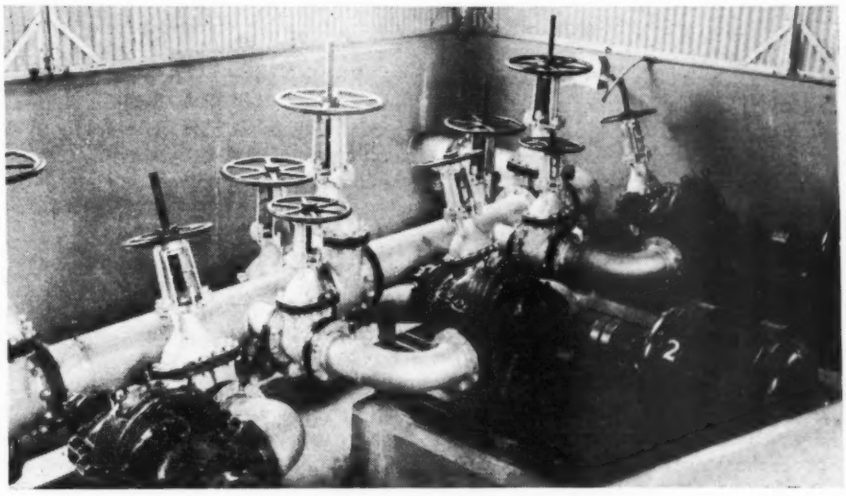
The 8-cylinder engines developing 400 hp. at 400 r.p.m. were selected to give the desired flexibility. They are convertible from gas to Diesel fuel if necessary, as the design of the units permits either fuel to be used when certain changes in piston design and cylinder liner diameter have been made.

The a-c. generators are rated at 312.5 kva., 250 kw., 80 percent power factor at 400 r.p.m., and generate 3-phase, 60-cycle current at 4160 volts. They are connected directly to the crankshafts of the prime movers.

This station was built near the high-pressure gas-compression station. A separate building housed the generators and engines, but the same tower was used to cool the water for both plants after its capacity had been increased somewhat.

The concrete engine blocks were poured on the sandstone bed rock. The units were set on 12-ft. centers, this distance providing ample space for operation and maintenance.

The steel building at the present time is 36 ft. wide and 132 ft. long and has 12-ft. walls. A separate I-beam over each engine facilitates the handling of heads and other parts too heavy for employees to handle unassisted. There are two dollies for attaching chain hoists, either of which may be transferred from one track to another as the necessity arises.

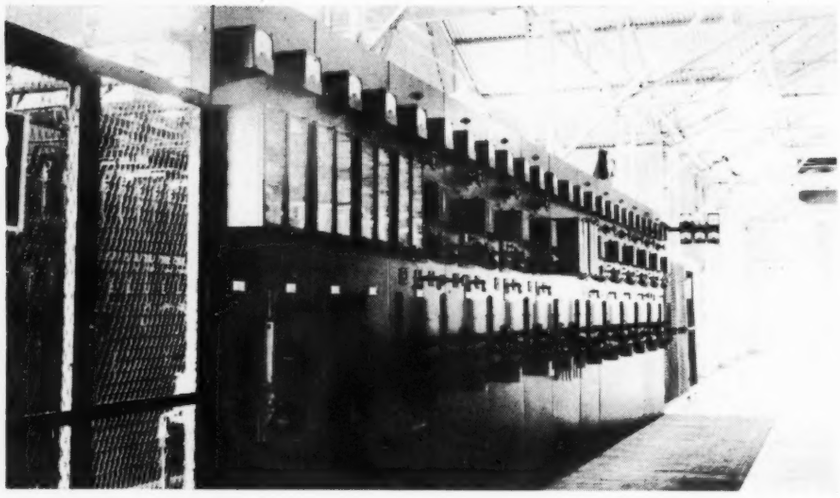


Centrifugal water pumps

Instead of a building having sufficient width to include switchboard and accessories, the standard building was purchased, and an 8-ft. by 48-ft. side-room was attached so the aisles could be cleared of equipment to eliminate some of the hazards common to electric generating stations in the field. This arrangement provides unobstructed passage-ways on each side of the main building, all instruments being flush with the side-wall.

Fuel for the ten 400-hp. units is residue gas from a near-by gasoline plant. It enters the plant at a pressure of 30 lb. gauge. Two regulators on the fuel system, either of which may be used while the other acts as standby, reduce the pressure to about one lb. as the gas enters the main fuel header. Each engine has a service regulator to reduce this pressure to that required for efficient operation. Air for combustion enters through piping from outside the building, each intake being equipped with an oil-bath air cleaner to remove dust and abrasives.

The steel service piping is buried be-



An 8-ft. by 48-ft. side-room is attached to the main building, housing the switchboard and accessories

low the floor when practicable, and is laid bare, as the soil in this area contains few "hot spots." As the cooling-water circulating pipes and fuel lines are below the floor, it is clear and easily kept clean, which fact promotes efficient operation. The engines exhaust through the roof, through jacketed cooling shells that prevent radiation of heat in the building during the hot summer months.

The building is ventilated and heated in the conventional manner. Ventilators on the roof permit escape of heated air and fumes from power units. Heating units are suspended from roof trusses, and circulating fans distribute warm or cool air throughout the building as necessary.

Engine-jacket cooling water circulates in a closed system. Zeolite-treated water is used to avoid deposition of scale-forming minerals. Raw, untreated water is cooled by pumping continuously over a tower on an 18-ft. substructure that extends the overall height to 55 feet. The tower is 114 ft. long, 8 ft. 2 in. wide, and 37 ft. high above the substructure, and contains 18 bays and 12 decks. It has sufficient capacity to reduce the temperature of 2400 gal. of water per minute from 99 deg. fahr. to 79 deg. fahr. under normal atmospheric conditions.

The untreated water flows by gravity from a 1600-bbl. wooden working tank to seven shell-and-tube exchangers, each having a diameter of 14 in. and a tube length of 156 in. and containing 394 sq. ft. of cooling surface. The $\frac{5}{8}$-in. tubes are made of Admiralty metal and are arranged in double pass. Water leaving the units flows to a receiver, or hot well, from which it is lifted by motor-driven centrifugal pumps to the cooling tower to complete the circuit.

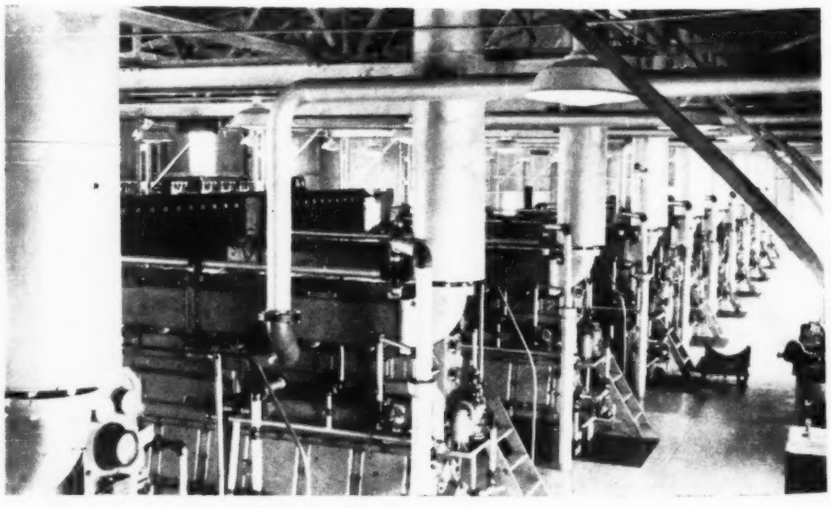
Treated water, having a hardness of $\frac{1}{2}$ grain or less, is pumped from a hot well through the shell of the exchangers to two standpipes, or elevated steel tanks, to provide adequate head for flowing through the engine jackets. Covers on the hot well and tanks prevent absorption of oxygen. The water flows in a continuous cycle, only a small volume being required for make-up. Frequent inspection of jackets and heads has disclosed no scale nor corrosion of metal surfaces; therefore no inhibitor is used to prevent rusting.

Engines are lubricated by a built-in lube oil pressure pump, which circulates oil from the engine sump through an oil strainer and an oil cooler, attached to the side of the unit, to each main bearing and through drilled passage-ways to all connecting-rod bearings. As the connecting rods are rifle-drilled, oil passes from the hollow crank to the wrist-pins and is distributed through ports to the cylinder walls and piston rings. Oil is periodically drained from the engine sumps and reconditioned by a special centrifuge called the oil conditioner.

The oil conditioner has a capacity of 100 gal. per hour when reconditioning lube oil having a viscosity of 200 seconds. The machine contains an 18-kw. oil heater and two pumps, one for dirty oil and the other for clean oil. Oil that has accumulated from several crank-case or oil sump drainings is cleaned by batch instead of continuous operation. The unit, including the 1-hp. motor and centrifuge, weighs approximately 775 lb. and requires but little space for operation, so it is set in a separate building.

The ten generators can be operated in parallel and are synchronized by means of the switchboard equipment. For each a-c. generator there is an individual 7½-kw., 1750-r.p.m., 125-volt, shunt-wound, V-belt-driven exciter. Each exciter is mounted on a strong and rigid framework above the generator outboard bearing pedestal. The driving belts are tightened by moving the exciter vertically by adjusting nuts on the base connecting bolts. This type of construction conserves floor space and the initial investment was less than it would have been for direct-connected units. The system is known as a "Unit-exciter System."

On the switchboard are mounted a power-factor indicator, a frequency indicator, and instruments for synchronizing the generators. Ten combined generator, exciter, and regulator panels and ten double-circuit feeder panels providing six outgoing feeder circuits are also included in the switchboard



The engines exhaust through the roof, through jacketed cooling shells that prevent radiation of heat in the building during the summer months

equipment. For safety the switchboard is arranged so that all equipment carrying high-voltage current is mounted remote from the panels. Only the instrument-transformer low-voltage secondary circuits for the various meters, instruments, etc., are brought to the steel switchboard panels. Each oil circuit breaker can be isolated from the high-voltage bus by disconnecting switches to provide safety to the operators when inspecting this equipment.

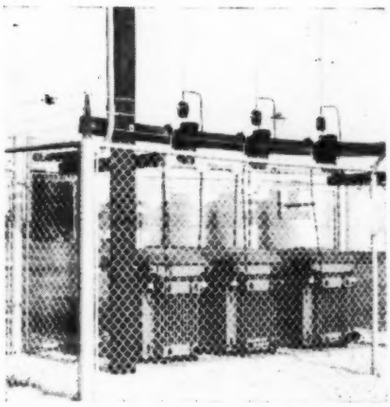
The design of the control room as an addition to the main engine-generator room provides space between the steel panels and the high-voltage equipment on the remote framework, ample for opening of disconnecting switches, inspection, or other work required of station operators. Suitable end screens are placed at each end of the switchboard to exclude unauthorized persons from the control room.

Each engine is equipped with a motor-operated governor, and a suitable governor-motor control switch is installed on each generator panel. This equipment enables the operator to vary the speed of the engine at will from his position at the switchboard in order to synchronize the unit with others.

A direct-acting automatic generator voltage regulator mounted on each generator panel provides an individual regulator for each exciter and generator. The voltage is automatically controlled by varying the exciter voltage, a function of the regulator, so generator field rheostats are not required. The regulator automatically divides the reactive kva. among the generators, allowing them to operate at maximum efficiency.

Complete control for each generating unit is confined to its particular switchboard panel. When it becomes necessary to install additional generator units, it is necessary to add to the present switchboard only a combined generator, exciter, and regulator panel and accessories for each unit added, similar to the panels now in use. Likewise, in moving one of the units to another location, the switchboard panel can be easily removed without affecting the operation of the remaining equipment.

As there are three feeder panels in the switchboard assembly, each panel having two mechanisms for operating oil circuit breakers, two ammeters, two sets of relays and two watthour meters, six outgoing feeder circuits are available for distribution of electrical energy. Induction-type overcurrent relays are used in the control circuits to trip the oil circuit breakers automatically.



The type of transformer station installed in Fitts Pool by E. H. Moore, Inc.

Current supplied to each division and lease is metered. The power plant and the gas compressor station consumed an average of 84,955 kw-hr. for the months of December, 1937, and January, February, and March, 1938. Of this amount, 47,421 kw-hr. was charged to the plant for illumination. A separate account is maintained for the generating equipment and the gas compressor station so that each unit may bear its prorated charge for services.

The following tabulation of generation costs is based on an operating time of four months—December, 1937, through March, 1938.

Labor	$ 619.65
Lubrication	479.97
Repair parts	76.27
Miscellaneous costs	56.18
Total	$1,232.07

Average monthly production being 913,179 kw-hr., the actual generating cost, based upon these four items, is $0.001349 per kilowatt hour. No charge has been made for depreciation, interest on investment, cost of water and gas, and current consumed by the station. The cost of current is $0.001349 per kw-hr. delivered at the bus, and the amount that the station consumed should be charged to cost of generation, which would increase the expenses of the plant by $114.60 per month.

As 4000 hp. or 2500 kw-hr. is available, and as the peak load has not exceeded 1620 kw-hr. on a one-hour test, considerable standby power is available when needed. Operating requirements of the engines are as follows:

Gas consumed per month (4-month average)	13,048,750 cu. ft.
Average gas consumed per kw-hr. produced	14.28 cu. ft.
Average fuel per hp-hr.	10.71 cu. ft.
Water used per hp-hr.	
Raw	.0685 bbl.
Treated	.000232 bbl.
Water used per month	
Raw	10,837 bbl.
Treated	367 bbl.
Average hp-hr. per gal. of lube oil	2165

Substations are erected where required, and consist of three transformers, either 50, 75, or 100 kva., depending upon the amount of power distributed by the station. The transformers are set on a concrete slab and are surrounded by a heavy woven mesh fence to protect persons and animals from injury. It was intended that each sub-station should serve only six locations, each well being drilled approximately in the center of a ten-acre tract, but because many additional

Portable transformer station used with electrified cleaning-out machine

wells have been drilled to lower zones, each substation serves six to fifteen wells.

Each well is weighed to determine its characteristics, and is equipped with tubing, rods, and pumping unit of the proper size. Wells producing from the Gilcrease formation at an average depth of 1832 ft. are equipped with 2-in. tubing and a 1¼-in. pump set at an average depth of 1804 feet. Only three wells are productive from the Gilcrease. Two of these are pumped by 10-hp. motors and the other by a 7½-hp. motor. These wells are pumped at an average cost of 1.67 cents per bbl. of oil lifted, based on the cost of current at the station bus.

There are 19 wells producing from the Cromwell sand. The average depth of these wells is 2611 feet. Tubing is set at an average depth of 2315 feet. Some wells are equipped with 2½-in. tubing and 1½-in. pumps, and others with 2-in. tubing and 1¼-in. pumps. The motors driving the pumping units are 10- or 15-hp., and the cost of lifting oil is 1.45 cents per bbl. based on the cost of current at the station bus.

Wells producing from the Hunton formation have an average depth of 3680 ft., and are equipped with 2-in. or 2½-in. tubing, set at an average depth of 3592 feet. The size of the pumping units, powered by 10-, 15-, or 25-hp. motors as the case may be, depends upon the amount of fluid to be lifted. The length of stroke of the pumps ranges from 34 to 72 in., and crank speed from 15.5 to 20.5 revolutions per minute. The pumping schedules range from time switch operation, pumping one hour and off for definite periods, to 24 hours a day, depending upon conditions in the well and the percentage of water produced with the oil. The cost of lifting oil from these wells is 2.72 cents per barrel.

By far the largest number of wells produce from the Simpson formation at an average depth of 4323 feet. The common tubing size is 2½ in. and most pumps are 1¾-in. but a few are 1½-in., set at an average depth of 4300 feet. Most of the wells are equipped with pumping units driven by 25-hp. or 40-hp. motors. Length of stroke ranges from 54 in. to 64 in. and the crank speed from 15 to 18.4 revolutions per minute. The fluid lifted requires a varying amount of power, but the average cost is about 2.95 cents per bbl., based on cost of current at generating station bus.

Most wells producing from the Wilcox are still flowing. Average depth is 4426 feet. The wells are equipped with 2½-in. tubing, set at an average depth of 4400 feet. A few wells are equipped with 1½-in. to 2-in. pumps. The motors driving the pumping units range from 10 to 40 hp., depending upon effectiveness of agitation. Length of stroke averages about 54 in. and crank speed about 14 revolutions per minute. Lifting costs are low, about 1.5 cents per bbl., little power being required as agitation causes flow through tubing. During the later life of these wells it is expected that costs will increase. Most of these wells are on "no schedule," producing whenever possible without fixed periods of operation.

About one-third of the wells are equipped with ⅞-in. rods, the other two-thirds with ¾-in. rods. Polished rods of steel were first used, but salt water corroded them, so alloy rods were substituted. Oil from practically all wells is pumped into separators, which procedure allows the gasoline plant operators to make trap connections instead of casinghead connections. Owing to the pressure and the amount of gas produced with the oil, separation after pumping is essential if gas is to be conserved and processed.

An average of 913,179 kw-hr. per month was generated in the four-month period, and an average of 812,002 kw-hr. was delivered to the field. The Wirick block consumed an average of 622,773 kw-hr., leaving a remainder of 189,218 kw-hr. to be delivered to outside leases. About 19 percent water is pumped, but the percentage is steadily increasing as the fluid level is lowered. The cost of energy used for pumping oil averages about $0.002385 per barrel.

A well-cleaning machine operates on current generated in the main station, taking power from distribution lines that lead to the wells. The unit is mounted on a steel skid base and is compactly arranged so that it can easily be placed on a truck for moving from one location to another. The unit closely resembles a standard drilling rig, as it has a wheel for bull-ropes, a sand line spool, a spool for tubing line, a crank, pitman, and walking beam, and the common accessories.

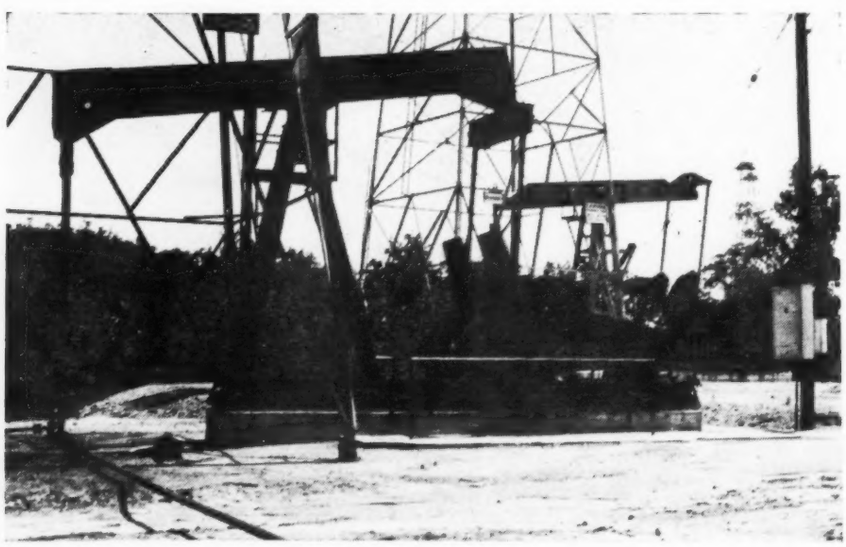
Instead of the band wheel, there is a sprocket driven by a chain from the motor. The motor is mounted on the steel skid frame and takes current through protected cables from the portable transformer unit. The transformers are installed in a specially built steel trailer having a cross-arm on the roof for attaching the cables to carry current to the well-cleaning machine.

Three of these machines are in use in the Fitts Pool. Compact enough for easy moving, the entire assembly may be skidded onto a truck without dismantling for transferring from one location to another.

The current consumption for these machines averages about 5540 kw-hr. per month, some wells requiring as much as 8600 kw-hr. for complete cleanout. Most wells require about 1750 kw-hr. and some may be cleaned for less.

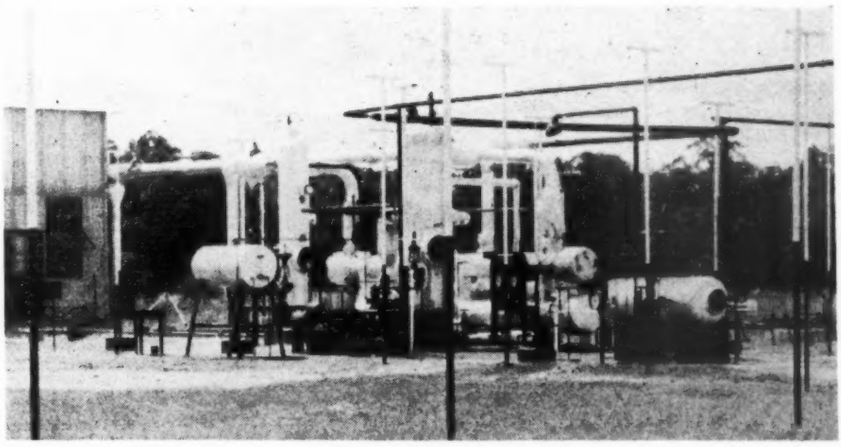
Summary of cable tool kw-hr. requirement

Job	*Kw. demand*	*Kw-hr.*
No. 2 Unit		
Patrick No. 5	64.5	6,210
Patrick No. 1	54	1,070
Geo. Smith No. 5	57	1,250
No. 3 Unit		
Burris No. 4	75	1,170
Cradduck No. 8	76.5	700
Cradduck No. 4	75	1,220
No. 4 Unit		
Woodruf No. 2	75	8,400
Total, kw-hr. cable tool operations		20,020



Twin wells, each having its separate pumping unit

The refrigerating unit



By
FRANK H. LOVE

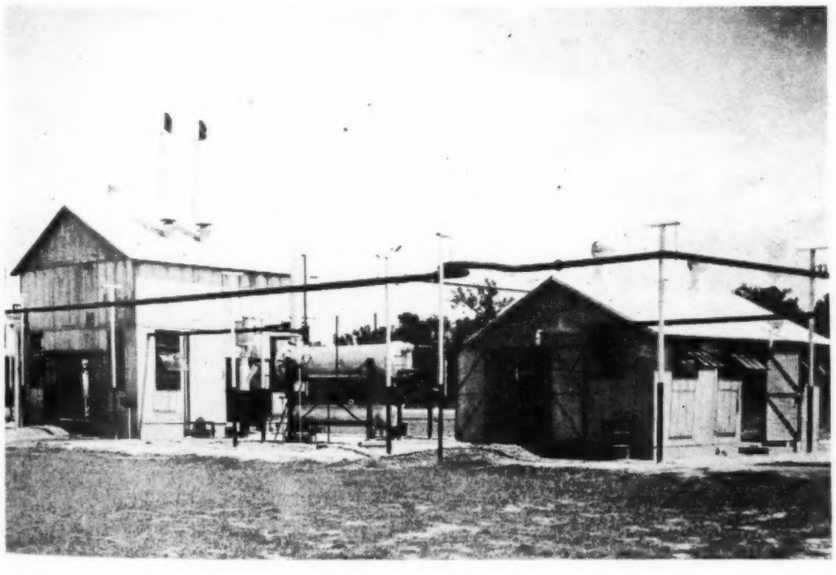
High-Pressure Refrigeration Extraction Recycling Plant at Cayuga

Natural condensate extracted from gas under high pressures, the residue being returned to the producing formation for repressuring

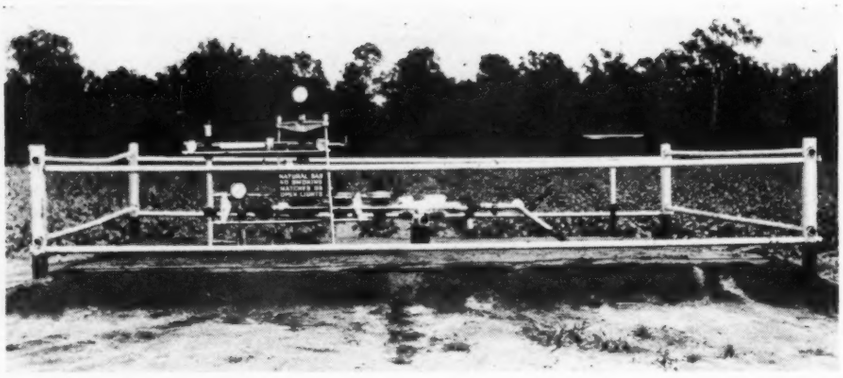
THE Tide Water Associated Oil Company and the Seaboard Oil Company's high-pressure refrigeration extraction recycling plant in the Cayuga field, Anderson County, Texas, is the first of its type to be constructed. The installation is for experimental and determination purposes, which work has not been completed, the plant having been in operation for but a few months. The process, for which patents are pending, involves the extraction of natural condensate from gas under high pressures, and includes refrigeration resulting from expansion of the gas and from the use of ammonia or other refrigerating agents to aid in obtaining the desired temperature. The equipment and the methods employed are for the purpose of obtaining subnormal temperatures efficiently at a minimum horsepower.

The application of such a plant seems virtually unlimited but problems connected with its operation, both as to safety and economics, are numerous. Before an installation is made an accurate survey of producing properties should first be conducted. Such a survey may reveal that the erection of a plant is impracticable, especially on a small property. In Texas only 25 percent of the well potential can be withdrawn from gas wells and it may be found that there is not enough gas to justify an installation. Permeability of the producing formation also is important as on it depends the volume of gas that can be withdrawn economically, as well as the volume that can be returned through an input well. Furthermore, the work is performed at high pressure and all equipment must be carefully designed and the proper size. Because of the high pressures there may be a tendency to make the equipment too small and insufficient size of equipment would result in a decrease in plant efficiency. On the other hand, to design the equipment larger than necessary would result in an unnecessary expenditure. It should be borne in mind, too, that for smooth operation high-pressure piping should be shop-fabricated, and for safety all high-pressure equipment should be carefully inspected and stress-relieved, and most of it X-rayed. Utmost precaution must be taken during construction and each operation watched carefully to assure the highest type of workmanship.

The success of a plant of this type depends on the thickness, porosity, and permeability of the producing formation, the amount of condensable hydrocarbons contained in each unit volume of gas, and other factors.



From left to right are the compressor building, the ammonia and gas expansion unit, and the auxiliary building



Residue gas from the plant is returned to the producing formation through this input well

Gas to supply the Cayuga plant is withdrawn from wells completed in the Woodbine sand and returned to input wells completed in the same formation. The condensate is extracted under high pressure to reduce the horsepower required to return the gas to the formation from which it was taken. When the plant was constructed little was known concerning the behavior of complex mixtures at high pressures and until quite recently no method of calculating the mechanics of condensation was available. The designer of the Cayuga plant was guided by results obtained from the operation of a small test plant, being prompted to make these tests by observing the behavior of gas from the deeper zones and by the belief that a revenue could be created for operators of large gas acreage who had no market available, particularly for gas containing an appreciable distillate content.

Equipment throughout the plant is of the latest design and is arranged to afford the greatest degree of efficiency, safety, and flexibility. Provision also has been made for addition of units if desired. The engine-compressor is a 400-hp. unit having vertical power cylinders and horizontal compressor cylinders. The ammonia and gas cylinders are attached to this unit. The plant being of an experimental design it was thought advisable to have all compressor work, both refrigeration and gas boosting, performed by the same unit.

All high-pressure vessels are stress-relieved and X-rayed, some being constructed of a special nickel-alloy steel. Most of the high-pressure piping was shop fabricated and all high-pressure joints and fittings are series 1500 ring gasket type. Water pumps, some of which are centrifugal and others reciprocating, are steam-driven.

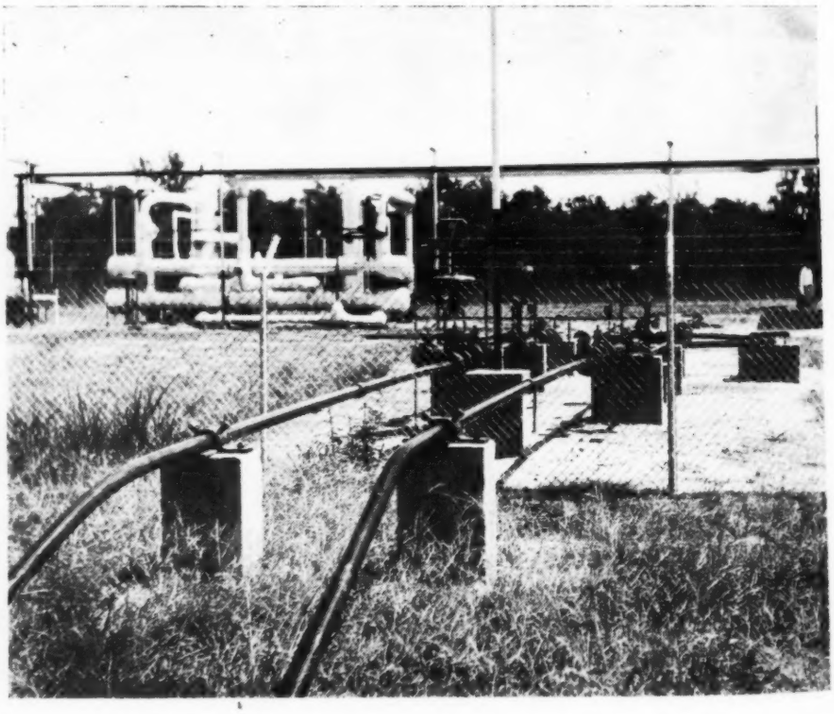
The plant is equipped for complete automatic control. An essential feature of a high-pressure plant is assurance of safety of operation. For this purpose a three-button control system was installed, the control buttons being placed in the plant office. One button closes a master valve on the gas fuel supply and pilot line to the boiler and opens a snuff valve on a steam line to the fire box of the boiler. A second button serves to ground the engine magneto, stopping the engine-compressor. A third button is for closing the stop valve on the main gas line into the plant. This valve also operates automatically on a pressure differential across the valve, so that should a line blow out on the plant side, the master stop valve would close, shutting off the incoming gas from the field. These valves remain closed until they are opened manually.

The engine-compressor is equipped with an automatic oil-pressure and water-temperature shut-down device. The accumulator on the suction of the unit is equipped with a mercoid switch that grounds the magneto and stops the engine before liquids can carry over into the compressor cylinders.

The laboratory is conveniently situated with respect to the plant and office. It is completely equipped so that tests can be made on all plant products and distillate produced from gas wells. Cold brine is circulated through the distillate condensers, eliminating the use of ice. Gas, steam, air, water, and ammonia lines are connected to the laboratory for convenience and control.

Since the plant was placed in operation it has proved capable of handling more gas than anticipated and it is now planned to connect other wells to the unit to test it thoroughly under full load. Expansion of the plant will depend upon the results of its operation under full load.

J. F. Pritchard and Company, Kansas City, Missouri, constructed the plant for the Tide Water Associated-Seaboard. William H. "Jack" Vaughan is the designer of the plant and originator of the process. George L. Barker and Jasper C. Dennis, gas engineers of the Tide Water Associated-Seaboard, assisted in the engineering work. L. D. Phillips, plant superintendent, and T. R. Wade, general field superintendent, are in charge of operations.



An inlet gas line, a return line to the input well, and the metering equipment

Special Material Used to Treat Mud Used for Drilling Through Cement

May be added before or after drilling-out cement to maintain or restore desirable properties of mud

By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles

THE mud used in drilling-out set cement in casing or open hole is frequently so contaminated with cement that it must be discarded. Not only is all the mud in the system lost but its disposal sometimes presents a problem. A substance has recently been developed to recondition such muds. During the last few months such mud from several California wells has been reclaimed and that from some wells has been improved over it original condition.

This material is a mixture of chemicals and a colloidal mud conditioner that, when added to the mud in suitable quantities, prevents the mud from flocculating and thickening. It may be used to pre-treat the mud in the system before it is contaminated with cement, or to treat the cement-cut mud, enough of the special treating compound being added to neutralize the effect of the calcium ion with which the mud is impregnated as a result of contact with the cement.

If there is a considerable amount of set cement to drill-out, it is advantageous to pre-treat the mud, otherwise it may become so thick that it will not flow through the mud ditch. Under these conditions it is very difficult to get anything to mix thoroughly with the mud. If there is only a small amount of cement to be drilled-out in proportion to the volume of mud in the hole and in the mud system, then the cement can be drilled-out first and the treating material added to the mud afterwards. It is the presence of the calcium ion that causes flocculation of the colloids in the drilling mud and the consequent loss of wall-building properties. A flocculated mud will deposit a thick filter cake on the walls of the hole and will allow a large loss of water into the formation. These two things account for many of the drilling difficulties commonly encountered. A thick mud cake frequently necessitates reaming to bottom after the drill pipe has been out of the hole. Loss of water to the formation is likely to cause sloughing, especially in shale bodies, which in turn may cause sticking of the pipe.

To determine the amount of compound to use it is best to calculate the number of pounds of set cement to be drilled-out. About twice the amount by weight of treating material is usually adequate to counteract the harmful effects of the calcium ion. The effectiveness of treatment is indicated by the pH value or hydrogen ion concentration of the treated mud. The pH of cement-cut mud usually is about 12. Experience has shown that when the pH decreases to about 10.8 the mud has been treated successfully and can be used in further drilling operations. Other measures of effectiveness of treatment are the viscosity and the wall-building characteristics of the mud. As the treatment progresses the viscosity will be reduced and there will be a noticeable decrease in the cake thickness and in the water loss.

The following data are typical of many jobs performed in California. There were about 600 bbl. of mud in the system. The mud was already cement-cut and the operators were faced with the problem of drilling-out 20 ft. of cement to a diameter of 12¼ inches. Before treatment the mud was tested and found to have the following characteristics:

Weight ..... 75 lb. per cu. foot
Funnel viscosity (500 cc. in and out) ..... 25 seconds
pH (Beckman) 12.5

Wall-building test (using a wall-building tester at 100 lb. per sq. inch):

Elapsed time, min.	*Total filtrate, cc.*
15	38.6
30	57.0
45	70.5
60	83.5

Cake thickness: ½ inch.

Circulation was begun and 100-lb. sacks of the treating material were added at five-minute intervals. When returns of treated mud were obtained the cement plug was drilled and treating material was added to counteract the effect of this new contamination. When the treatment was complete, the mud was ready for use in drilling and had the following characteristics:

Weight ..... 74 lb. per cu. foot
Funnel viscosity (500 cc.) ..... 32 seconds
pH (Beckman) 9.5

Wall-building test (using a wall-building tester at 100 lb. per sq. inch):

Elapsed time, min.	*Total filtrate, cc.*
15	11.5
30	16.0
45	19.0
60	21.5

Cake thickness: 1/16 inch.

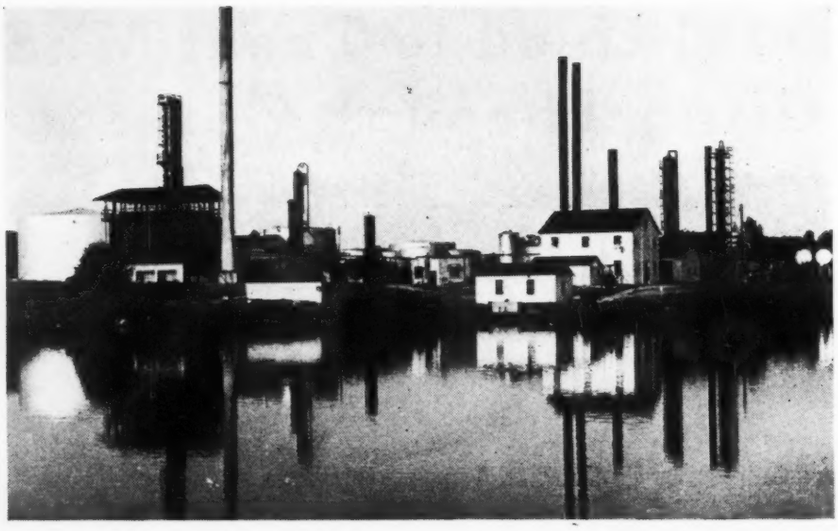
The results may be summarized as follows:

Total mud treated ..... 600 barrels
Total time of treatment ..... 15 hours
Treating material used ..... 47 sacks
Total cost of treatment $175.00
Total cost of replacing cement-cut mud with average mud $300.00
Approximate saving $125.00

The treated mud had good gel properties, formed a thin filter cake, lost little water to the formation, and facilitated the running of the liner. Besides the actual saving in money there was no loss of time and no disposal problem, which in some fields is quite serious. The treatment of weighted muds is especially economical.

ACKNOWLEDGMENT

The writer wishes to acknowledge the assistance of W. L. Heater, Pacific Coast manager, Baroid Sales Department, National Lead Company, in supplying data for this article.



View of the McClanahan refinery at St. Louis, Michigan

By
NORMAN X. LYON

Refinery Construction Active in Michigan

AN estimated one and a half to two million dollars is being expended this year on modernization and expansion of Michigan refineries, and two new plants recently have been constructed and placed in operation, one a straight-run refinery and the other a casinghead gasoline plant. Another unit, originally built as a straight-run refinery, has been converted into an asphalt plant.

With one exception, Michigan refineries obtain their crude supply from Michigan fields and are independently owned. The exception is the Socony-Vacuum's 15,000-bbl. refinery at Trenton, which operates principally on Mid-Continent crudes. This company is now constructing a new 20,000-bbl. combination cracking unit.

The only new refinery completed in Michigan this year is the Bay Refining Company's 4000-bbl. straight-run plant at Bay City, on the deep-water terminal of Saginaw Bay. The plant has been in operation since April 1.

The Roosevelt Refining Company is expending about $350,000 this year for modernization and expansion of its refinery at Mt. Pleasant. Placed in operation last month was a new 1250-bbl. combination cracking unit, the newest addition to the 5000-bbl. straight-run plant. Another addition this year was an Ethyl blending unit. Scheduled for construction this fall is a new lube unit and possibly a polymerization unit to replace the present gas-absorbing plant.

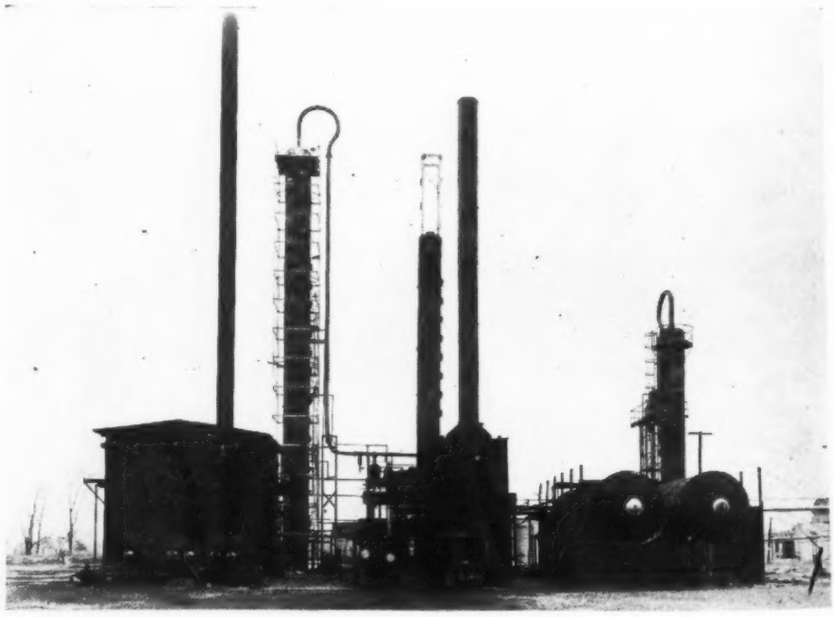
Old Dutch Refining Company, organized in 1929, temporarily suspended operation of its 3000-bbl. combination plant at Muskegon last year but under re-organization the plant went back on stream early this year. The true vapor-phase cracking and reforming unit has 1500-bbl. capacity. A new asphalt plant was placed in operation last month.

Naph-Sol Refining Company, Muskegon, which operates a 4500-bbl. straight-run and a 1500-bbl. cracking unit, this spring added an Ethyl blending unit and 105,000 bbl. of new storage.

Total storage constructed this year by Michigan refineries is estimated at a half million barrels.

The Trumbull Asphalt and Refining Company of Chicago in June leased the Wolverine Petroleum Lube Oil Company plant at Alma and immediately placed it in operation. About two cars per day of asphalt flux is being produced at present.

Michigan refineries are processing 35,000 to 40,000 bbl. of crude oil daily from Michigan fields. Michigan oil production averaged 52,884 bbl. per day in June and 56,851 bbl. in May.



New asphalt plant and topping unit, Old Dutch Refinery, Muskegon

Exterior of the pump house and top of the shaft

The World's Largest Water Well†

By LEO RANNEY*

THE wastes of the Mojave Desert of California are peopled by rattlesnakes, scorpions, and road runners. The scattered greasewood, sage brush, and shadscale cling tenaciously to life under a broiling sun. Only once in the year do the groves of joshua trees seem glad to live—and then they burst into a bloom fit for the Garden of Eden.

But in the south center of this seemingly useless ocean of sand is a long line of poplar and willow trees, and the desert rat knows them as indicators of water within 25 or 30 ft. of the surface. The fact is that here is an underground river dammed by a hidden dyke into a buried lake. Enough water lies 50 ft. underground to transform the barren surface into miles of gardens.

Under most of the populated parts of the earth these invisible rivers and lakes are ready to give life—man's problem is to get the water to the surface in an economic and unfailing supply. How to do this most efficiently has been a major problem from time immemorial. The farmer does it to his own satisfaction simply because his household and his stock consume but little, but with the growth of cities, irrigation projects, and great industries the problem may become acute.

Aptly termed "A Glorified Water Well," the Water Collector here described is a development of interest to the oil industry, suggesting as it does a possible method of exploiting shallow deposits of oil; also a possible means of developing for refineries an adequate supply of cooling water of suitable temperature.

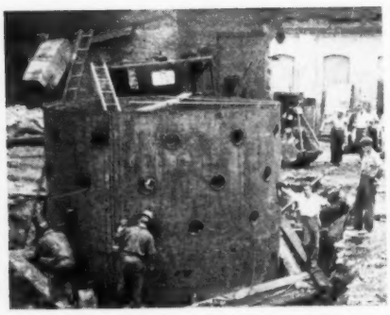
The author has been interested for many years in mining methods for oil and the Water Collector is really an evolution of the method he developed for mining oil sands.

Characteristics of Ground Water Deposits

In most places ground water lies in relatively thin sheets. Replenishment of

†This paper was read before the 1938 Illinois Spring Meeting of the American Waterworks Association.

*Petroleum engineer. The method described herein is covered by patents and patent applications in 26 countries, including the United States.



The double-walled "porthole" section of the Canton shaft, welded to the shoe. The space between shells is to be filled with concrete

withdrawals at any given point (except where abstraction is made from the sand and gravel of river beds) must be by lateral filtration to the well. Therefore, the collecting area of the water screen should be as large as possible, to reduce the rate of flow through the aquifer.

Where hardness of ground water is a problem, the nearer the surface the point of abstraction, the softer will be the water produced. Therefore, the bottom of the water deposit should not be drawn upon where it can possibly be avoided.

Most water-bearing sands and gravels contain silt, and this silt and fine sand are carried along when the velocity of the moving water passes a critical point. Therefore, the rate of flow towards and into the well should be as low as possible to avoid sanding-up and plugging of the screens.

Where the water is hard, any noticeable reduction of pressure at the point of abstraction may cause a release of carbon dioxide gas, which in turn results in a precipitated deposit of lime, magnesium, and iron to form a conglomerate rock that chokes the collecting screens. Therefore, the drawdown in a pumping well should be as small as possible.

Problems of Vertical Wells

Most of the problems of vertical wells may be summed up in one major or parent problem, and that is that the effective length of the screen is limited by the thickness of the aquifer. For example, if a water-bearing sand or gravel is only 15 ft. thick, it is utterly impossible to sink a vertical screen pipe thereinto with more than 15 ft. in contact with the sand body. Of course the collecting circumference of the vertical well can be somewhat increased by building a gravel wall around the screen.

Difficulties might never arise if the vertical wells were always pumped at only a small fraction of their capacity so that the rate of flow through the screen openings would always be kept below .03 ft. per second, but, to save the cost of a seeming surplus of wells, this is almost never done. An excessive rate of abstraction causes a rate of flow through the gravel beyond the critical velocity, resulting in silting-up or encrustation of the well screen.

Development of the Water Collector

To the writer it seemed that the only practical way to provide a length of screen pipe greater than the thickness of the sand was to install *horizontal* screens, not limited in number and not limited in length except by property lines and ability to project the pipes. In other words, instead of one vertical well, there would be several gravel-walled horizontal wells emptying into one shaft. Such a glorified well or Water Collector has the collecting capacity of a vertical well as large as the area emptying directly into the horizontal screen pipes. For example, if these pipes are projected 250 ft. from the shaft, then the Collector has approximately the effectiveness of an open well 500 ft. in diameter. Projection may be accomplished at any desired level in the sand.

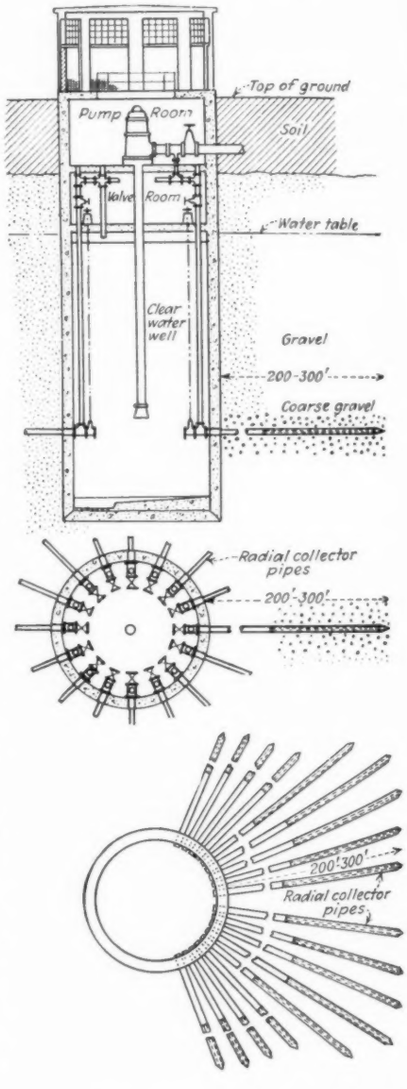
Two major problems presented themselves at once: First, to be able to project screen pipes as large as 8 in. or 10 in. in diameter several hundred feet into sand or gravel, when ordinarily they might be expected to collapse within 20 feet. Second, to place a gravel pack, in situ, around each screen pipe throughout its entire length. Both these ends were attained by one invention—the digging head and sand-discharge assembly associated with the screen pipe during projection.

Without going into burdensome details of construction, the digging head on the forward end of each pipe removes the fine material from the path of the screen pipe and at the same time digs a channel for the pipe to follow. The gravel stones in the formation are pushed aside and packed along the screen pipe.

To illustrate the action of the digging head, in the installation made by the writer for the Metropolitan Water Board of London, England, the inside diameter of the screen pipes was only 7 in. but 2 cu. ft. of fine material was removed for each foot of pipe projected. In the Canton, Ohio, installation 3 cu. ft. of fine material was extracted for each foot of pipe installed. All the Canton gravel packs, radiating from the shaft like spokes in a wheel, each pack drained by its own pipe, contain some 80,000 cu. ft. of gravel deposited in situ by this method. The gravel lies loosely, that adjacent to the pipe having a porosity of 35 percent to 45 percent.

In the common gravel-walled well the gravel pack is referred to as a filter. This is correct. The gravel filters the fine sand from the water moving rapidly towards the well. But the gravel packs in the Water Collector are *not* filters, as the water moves so slowly that it carries no fine sand to be filtered. In the Canton installation the velocity of the water entering the gravel bed around each screen pipe is about .002 ft. or 1/40 in. per second. Such water carries no fine sand. Therefore, the only purpose of the gravel is

Cross-section and plan of Collector showing screen pipes



The hydraulic jacks in use under a pressure of 4000 lb. per sq. in., capable of delivering a pressure of 150 tons

to support the water-bearing sand and to hold it away from the screen pipe.

The Ranney Water Collector at Canton, Ohio

This glorified well was installed by the Timken Roller Bearing Company, for themselves under the superintendence of Mr. C. M. Maratta, plant maintenance engineer.

The shaft of the Collector is 147.5 ft. deep and 12.5 ft. in diameter inside, and the shoe is 15.5 ft. in outside diameter. The bottom 20 ft., containing the "portholes," is lined with ½-in. welded boiler plate and backed by reinforced concrete 18 in. thick and another steel plate ¼ in. thick. Thirty-six 10-in. "portholes" were provided in three staggered circles for the projection of 8-in. screen pipes.

Each porthole was made of extra-heavy 10-in. pipe, welded to the inner and outer steel coverings of the concrete, and had a shoulder turned in the inside of the outer end. Against this shoulder was driven from the outside a 2-in. oak disk or plug to close the port during sinking of the shaft. The inner end of each porthole was flanged to receive a 10-in. gate valve, and on this flange was bolted a ½-in. steel plate for safety and protection. The water table was 38 ft. below the top of the ground.

The shaft or caisson was sunk by digging material from the center. As the caisson settled it was built up on the surface. At the top the reinforced concrete wall is 6 in. thick. The liner also diminished toward the top to ⅛ in. in thickness. When the shaft had reached the desired depth a concrete plug was poured in the bottom, then, for the first time the shaft was unwatered. No compressed air was used in sinking. Except for the portholes, there was nothing new about the shaft—the same method of sinking is universally used by contractors.

Projecting the Screen Pipes

The screen pipes of the Ranney Water Collector at Canton are of ⅜-in. Toncan metal, in 7½-ft. lengths, 8 in. in inside diameter, beveled on the ends for welding together into a continuous tube. The metal was punched in the flat with 1150 slots, ¼ in. by 1½ in., in each length—in all, 430,000 slots. Each section of pipe contains 3 sq. ft. of open hole in its perforations—a little less than 20 percent of its outside area.

The total area of open hole of the perforations in all the 2800 ft. of screen pipe amounts to 1120 sq. feet. To place anything like this length of pipe in a vertical well in any known aquifer would of course be impossible. Every foot of this total length of pipe lies 100 ft. below the water table—another accomplishment impossible in a vertical well.

The first step in projecting a screen pipe was the removal of the porthole plate from its flange and the attaching of a strong rubber stuffing box shaped like a silk "top-hat," the "top" pointed away from the center of the shaft. Against the brim of the "top-hat" was bolted a 10-in. gate valve, through which the pipes were pushed. Projection was from a stirrup between two hydraulic jacks capable of delivering a pressure of 150 tons.

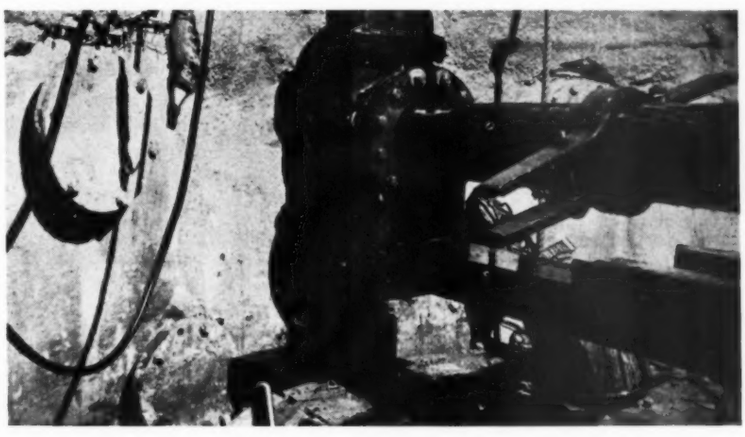
The cast-steel digging head, like a great spear, was forced through the oak block in the outer end of the porthole, destroying the block like matchwood. Sand and silt were delivered from the interior of the digging head to the center of the shaft by a double-extra-heavy 2-in. pipe in 7½-ft. sections. The annular space between the screen pipe and the sand-discharge pipe was kept closed by a specially built sliding packer, designed to hold back the pressure of the 100-ft. head of water in the ground. The sliding packer never passes beyond the shaft wall in either direction.

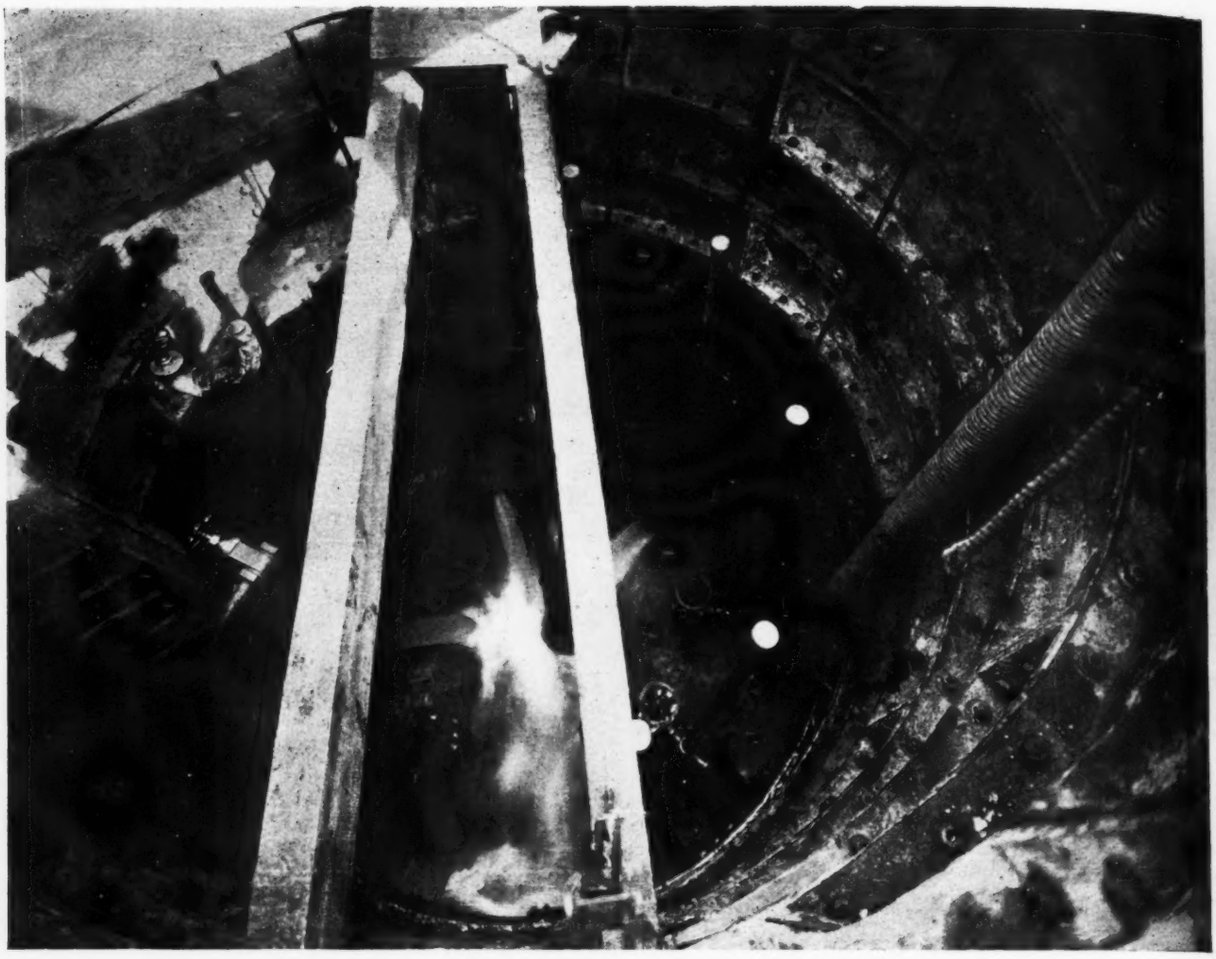
When a section of screen pipe had been pushed almost flush with the gate valve, the jacks were withdrawn, a new section of sand-discharge pipe added, then a new section of screen pipe welded to the projecting end of the last section, the sliding packer moved back 7½ ft., and pressure again applied by the jacks. Sand and silt were delivered in a solid 2-in. stream from the side of the driving block that transmitted pressure from the jacks to the screen pipe. These fines were pumped from the sump in the bottom of the shaft to the surface.

When a screen pipe had been projected to the desired distance, the sand-discharge pipe was disconnected from the digging head by a left-hand thread and withdrawn; the sliding packer was removed; the gate valve was closed, and the jacking equipment moved to the next porthole.

The lengths of the separate horizontal wells or screen pipes was limited by property lines, the longest one being 175 ft. in length. In favorable mate-

One of the screen pipes being jacked out through a 10-in. gate valve and its "porthole" into gravel under a head of 100 ft. of water





Looking down at the horizontal wells of the London (England) Collector while three valves were being opened, under a head of only six feet

rial the pipes could be projected several hundred feet. Stones as large as 8 in. in diameter (as indicated by the shaft excavation) may be loosened and pushed aside by the action of the digging head, but thick banks of clay may not be passed through without jetting.

In difficult ground containing large clay balls and other obstructions, a water jet may sometimes be used. In jetting thus, the hose containing high pressure water is attached to the connection in the side of the driving block, and through this to the sand-discharge pipe in the center of the screen pipe. The sand-discharge pipe carries the jet water to the hollow center of the digging head, then through slots therein against the material in the path of the screen pipe to be jetted.

Where the head of water in the ground is too low to flush the sand from the sand-discharge pipe, a suction of the eductor type has been applied thereto to speed the flow away from the digging head.

When all the screen pipes of the Canton installation had been projected to the desired length, the valve stems were extended upward to a circular working platform above the water table. Each valve stem weighs 300 lb. and is supported by Timken roller thrust bearings.

Performance

On completion of the Collector, before four of the gate valves could be opened the water in the shaft had risen to the ground water table, the average rate of flow from only these four of the 36 horizontal wells being 22,000 gal. per minute, or 32,000,000 gal. daily, under an average head of 50 feet.

The Collector has now had a year's trial. The drawdown in the shaft during normal production of 12,000,000 gal. per day is about 7 ft. below the original water table before the pumps are started, but from the performance of the London Collector we may assume that the normal pumping level in the shaft is only a few inches below the static level immediately outside the shaft.

The velocity of water through the screen openings at this rate of production is about .015 ft. per second—less than 1/5 inch. This compares with a former velocity as high as 3 ft. per second through the screen openings of the now unused gravel-walled wells in the same area. Because of the abundant replenishment in this preglacial river valley, the general water table a few hundred feet from the shaft is not lowered.

At such a low velocity of water into the screen pipes, it is doubtful whether encrustations will form on the screens in two or three generations, whereas in the former wells encrustations almost completely stopped the flow within a few years. It is reported that a saving of many thousands of dollars a year is effected because the Collector water is softer than that from wells,

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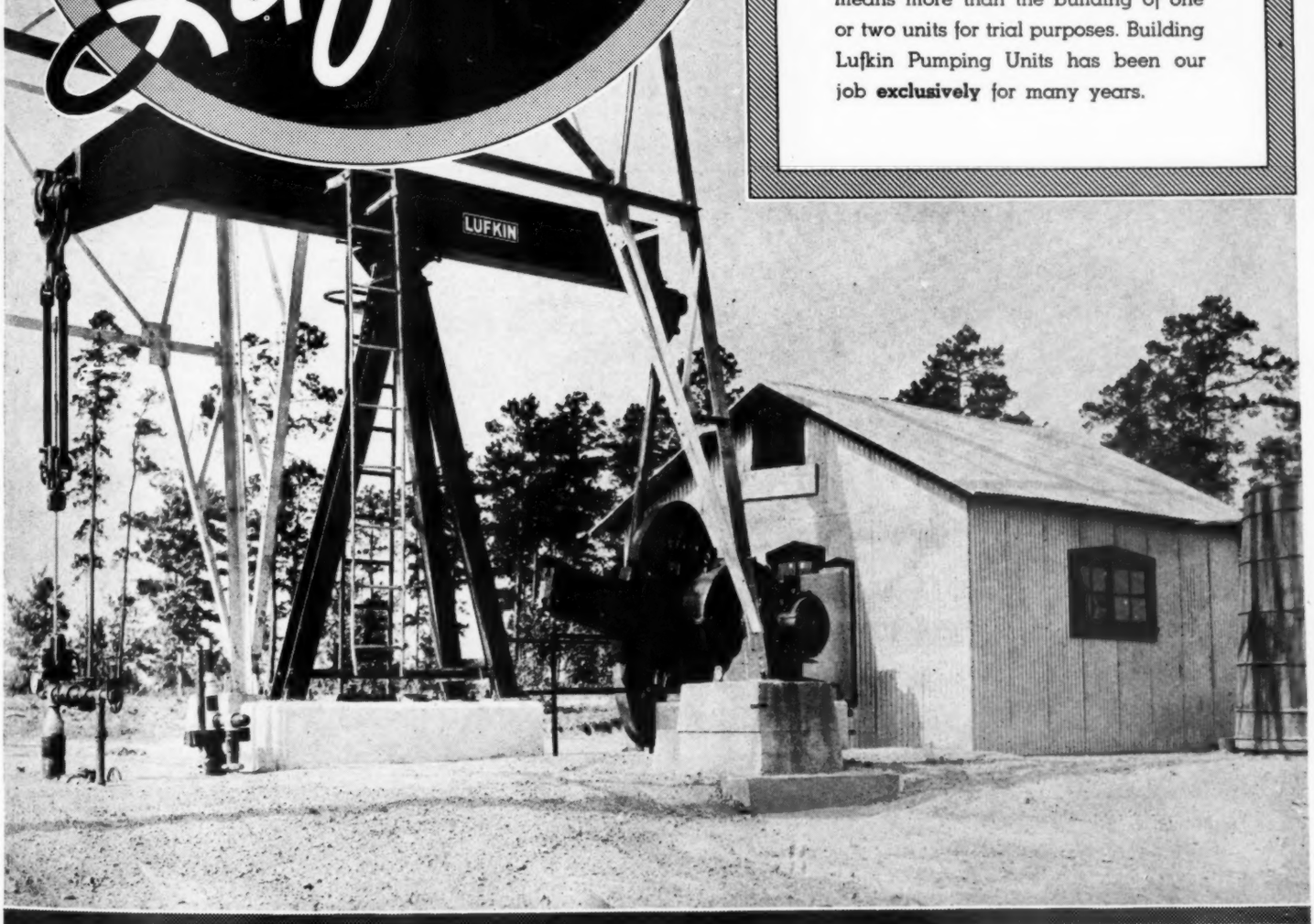


LUFKIN PUMPING UNITS

LUFKIN UNITS are manufactured in Lufkin, Texas, by the Lufkin Foundry & Machine Company. Branches in principal oil centers

as it is taken from a higher zone than that tapped by the wells, some of which were 220 ft. deep.

Theoretical Capacity

Assuming that sufficient pumping capacity could be installed in the Ranney Water Collector at Canton, a careful search of the records of ancient and modern wells indicates that it has a possible emergency capacity several times as great as any other true water well ever built by man.

To lower the pumping level in the shaft by 100 ft. would require the production of the enormous total of some 168,000,000 gal. of water per day or four million barrels—more than 100,000 gal. per minute. Flowing through a 12-in. pipe, this stream would have to move at the rate of three miles a minute—three times as fast as the midnight express.

The industries of Canton, Ohio, use about 40,000,000 gal. of water daily, the city itself some 15,000,000 gal.—all of this from wells. If all other wells in the city should suddenly fail, this Water Collector could furnish enough water in the emergency to supply the city and all her industries and have a surplus capacity sufficient for another city of 1,000,000 inhabitants.

Possible Applications of the Method

Obviously, the Water Collector is applicable to locations in which ground water occurs at reasonable depths, either in sand or gravel formations. In sand a substitute is provided for the radiating gravel beds. When the water-bearing material is sandstone, open holes are drilled horizontally into the sand rock from the shaft bottom by means of diamond drills. Such holes may be 1000 to 2000 ft. in length. In drilling horizontal oil wells in sandstone the writer has developed a method of maintaining the level of holes or curving them upward or downward, to depths as great as the equipment is capable of attaining.

In London the production of the Collector is equal to that of 40 wells in the same locality and formation.

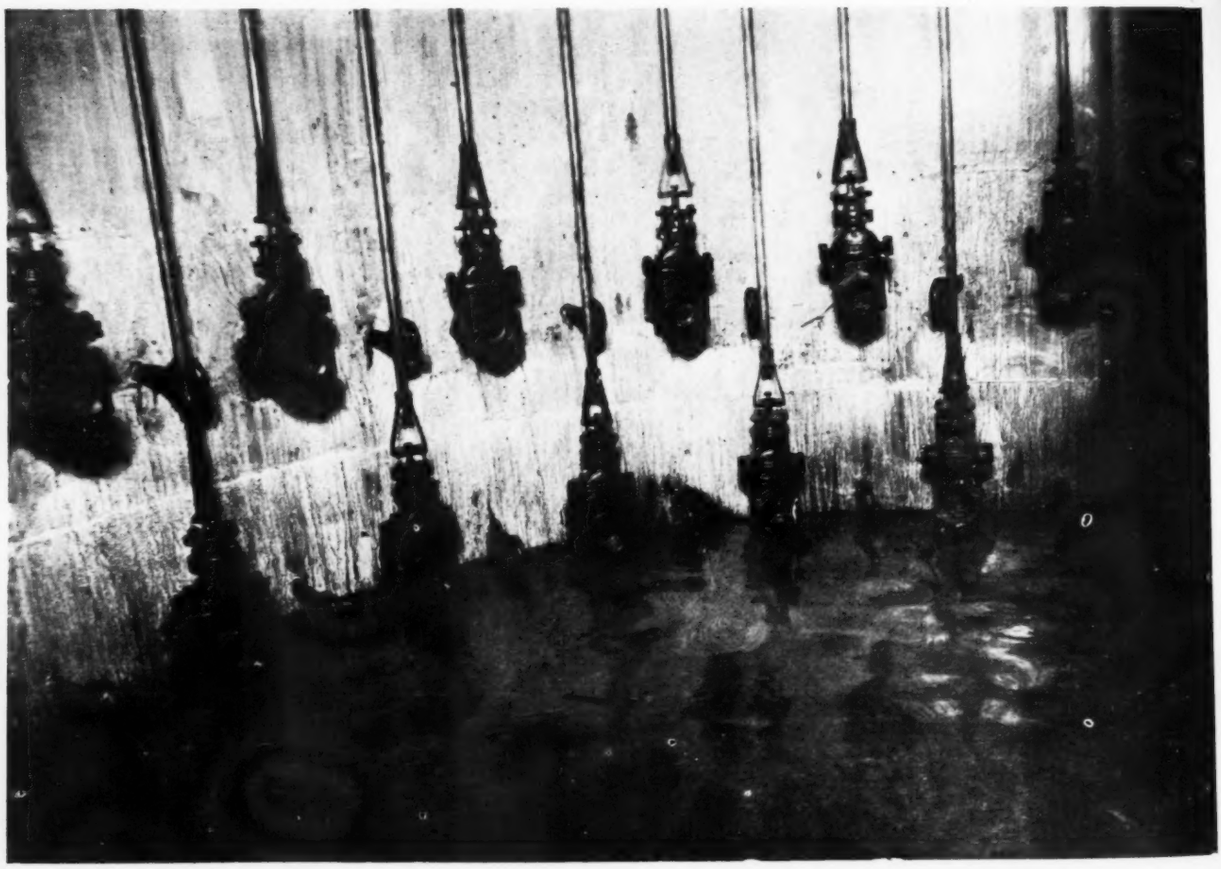
Many factors, too numerous for discussion here, enter into consideration of a Collector for any given location, but, generally, the basic factors are the local value of water and the cost of producing it by other methods.

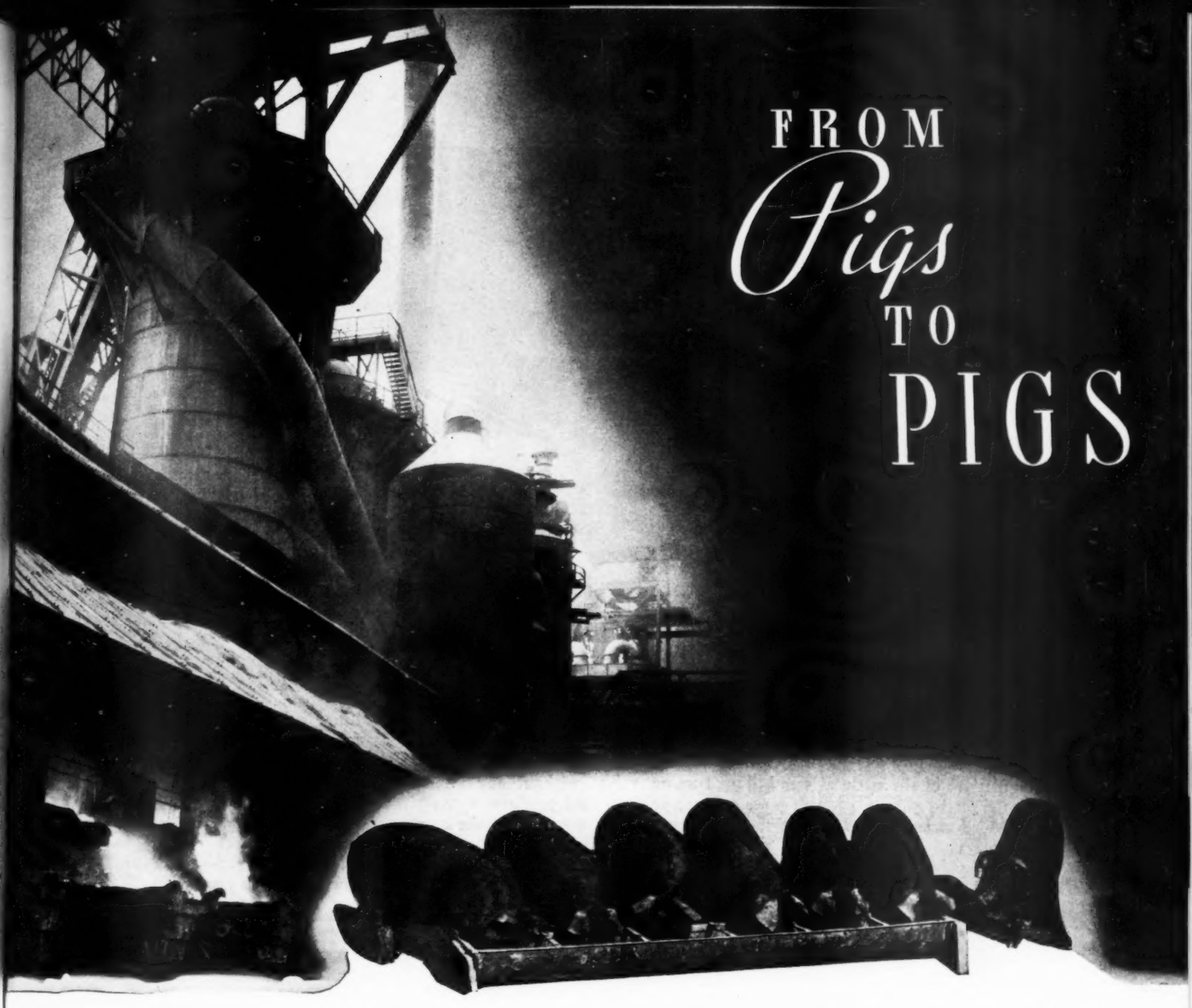
Water Collectors are suggested especially for locations where water may be drawn from the gravel underlying lakes or streams. The first benefit from such an application lies in the elimination of costly intakes that are always an item of expense to maintain and frequently to rebuild. With this elimination of open intakes there vanishes a source of possible pollution. Neither ice, oil, garbage, nor driftwood can reach or pollute the horizontal screens of a Collector many feet below the bottom of a lake or stream, nor can any flood wash them out. Their span of life is the same as that of the nickel cast iron of which they are built.

Costly filters, always a burden to operate, but necessary where raw water is drawn from a stream, disappear with the intakes. Often the filters alone would cost twice as much as a complete Collector, which would deliver water free of sand and silt. This water would be much purer bacterialogically than the raw water, as it would be filtered naturally through many feet of sand and gravel.

Water Collectors are not affected by

Showing arrangement of gate valves and valve stems in one or more circles of horizontal wells—without backwash pipes. A small installation





★"Modern" applies today to farms as well as cities--and *steel* has made this true. A sizeable percentage of the "pigs" (masses of metal cast in a mold) from all blast furnaces find their way to the farms in the form of steel---in plows and in modern equipment which increases production; granaries that protect the harvest; pipe, pumps and troughs by which animals are fed and watered.

On an average farm are hundreds of uses for steel. Look around your home--whether farm or city--and note how much you, too, depend on steel --hinges, stoves, cooking utensils, refrigerator, plumbing, heating and countless other uses.

Not, of course, just any steel. There are actually thousands of kinds of steel, and we have spent years and millions of dollars to equip ourselves to work with you, to find which will exactly meet your needs. No matter how small the order may be every Youngstown resource for quality is employed in its production.

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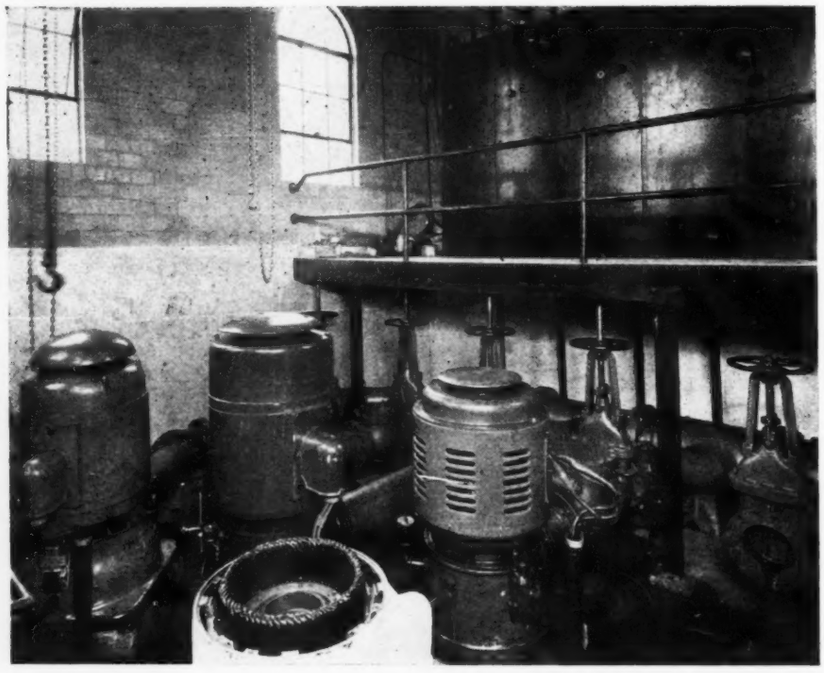
YOUNGSTOWN



The interior of the pump house on the top of the shaft. The pumps have a capacity of 18,000,000 gallons of water daily

accumulations of silt in the stream bed above the screen pipes. Backwash pipes are provided to wash the silt from the bottom of the stream and from the underlying gravel. Backwashing is accomplished in a few hours by simply turning valves without any interference with normal production. As the silt is washed upward into the stream it is carried away by the current.

Collector water may be many degrees cooler than raw river water, and softer than well water in the same general area. In manufacturing plants this uniformly cool water, for use in condensers and elsewhere, may increase plant capacity and reduce circulation costs. It should often meet the growing requirements of air conditioning, where cool water is required.

As regards the receding water table that worries many communities, practically the same installation is adaptable for charging surplus or flood water into deeper gravels to raise the ground water level. Such a plan is now being considered in London for charging flood water of the Thames through 100 ft. of London clay down into the 600 ft. of porous chalk beneath the city. Such recharging could be done at the rate of 500 to 1000 million gal. daily. This would eliminate the vulnerability of the weakest point in the defense of London—her water supply. At present, her great, shallow, open reservoirs are shining marks for enemy airplanes, which in one midnight raid could render her stored water unpotable.

The methods used by the Water Collector are so new and so radically different from those that it may replace that it will be years before its various applications will be discovered. And, like the drilling of wells, improvements will be developed therein that will make the process economical and desirable in situations where its use may not now seem to be justified.

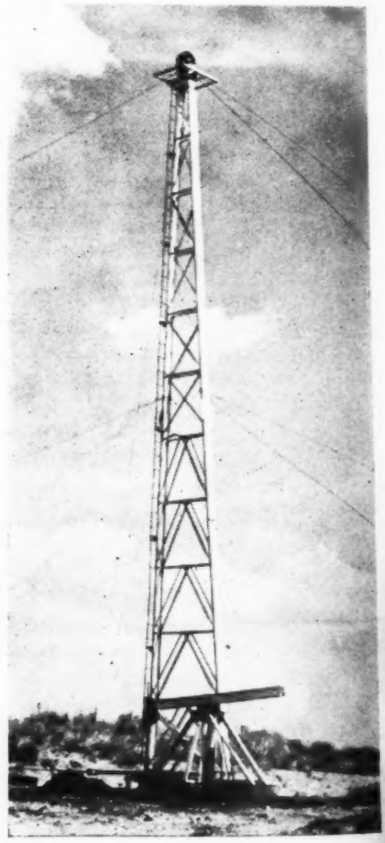
Steel Masts Used to Service Pumping Wells in Texas Panhandle

WHEN most wells in the Texas Panhandle were placed on production the original derrick was allowed to stand. Some of these derricks are still in service, but many of them were made of wood, and most of those have been replaced with steel derricks or masts of various sorts. Some of these masts are made of old pipe, casing, or tubing. Most of them have two risers, as an A-frame, and are set on concrete foundations.

The trend in the Panhandle is toward erection of structural steel masts, fabricated before shipment, and designed to service pumping wells. In the field east of Borger most of the original derricks have been removed, either because of danger due to rotted sills and legs, or because of the unsightly appearance.

Where structural steel masts are used, a substantial hook for the attachment of tubing and rod line snatch blocks is set in a concrete block near the well. The sub-structure and the mast are connected by bolts that lock the structure firmly to the foundation. A large bearing bolt is used to couple the two members to each other to anchor the mast firmly to the sub-structure when raising it into position. After the mast is raised, it is secured by several bolts in flanges of the substructure and the lower end of the mast legs.

There is a double sheave at the top of the mast and guy line eyes at the top and near the middle. Ordinarily eight wires are needed to hold the mast in position, because of the high winds that sweep across the North Plains, and because of the necessity of holding the mast rigid when pulling long strings of tubing.



The type of mast used to service wells in Texas Panhandle after drilling derrick is removed

TWIN ECONOMIES

TWO PORTLAND CEMENTS—BOTH MADE FOR OIL WELLS

USE 'STARCOR'— for deep wells, high temperatures, extra sulphate resistance.

USE 'INCOR'— for wells of moderate depth, and low temperatures.

WHEN you set a whipstock, isn't it a fact that you've got to have a good, strong cement under it? "Sure thing—*or else!*" Meaning that, if the cement doesn't set plenty hard, you're back in the old hole before you know it. But, not when you use the right kind of cement. Listen to an Oil Man's say-so:

"A week or so ago, I was on a water location where they had set a whipstock and were kicking off—just like that! Why? Simply because they had plugged back with 'Incor'. In 3 days from the time it was run, 'Incor' was harder than the formation —when you use 'Incor', the bit always kicks off!"

But, remember, for high temperatures use 'Starcor'. Even at high temperatures, 'Starcor' acts just like 'Incor', except that it stays pumpable longer. The money-saving twins for oil-well cementing— 'Starcor'* and 'Incor'*—just select the one which fits the job in hand.

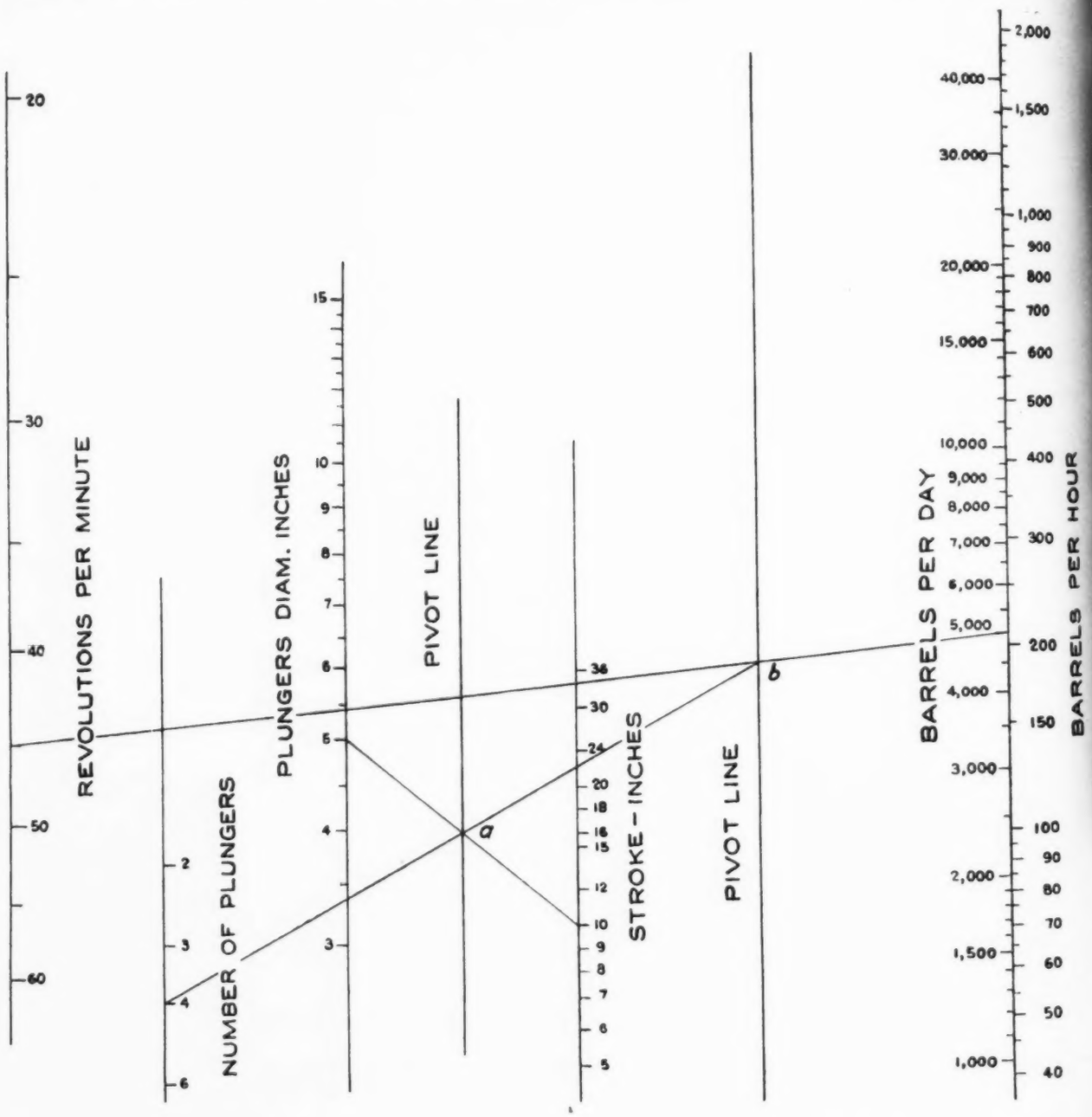
*Reg. U. S. Pat. Off.

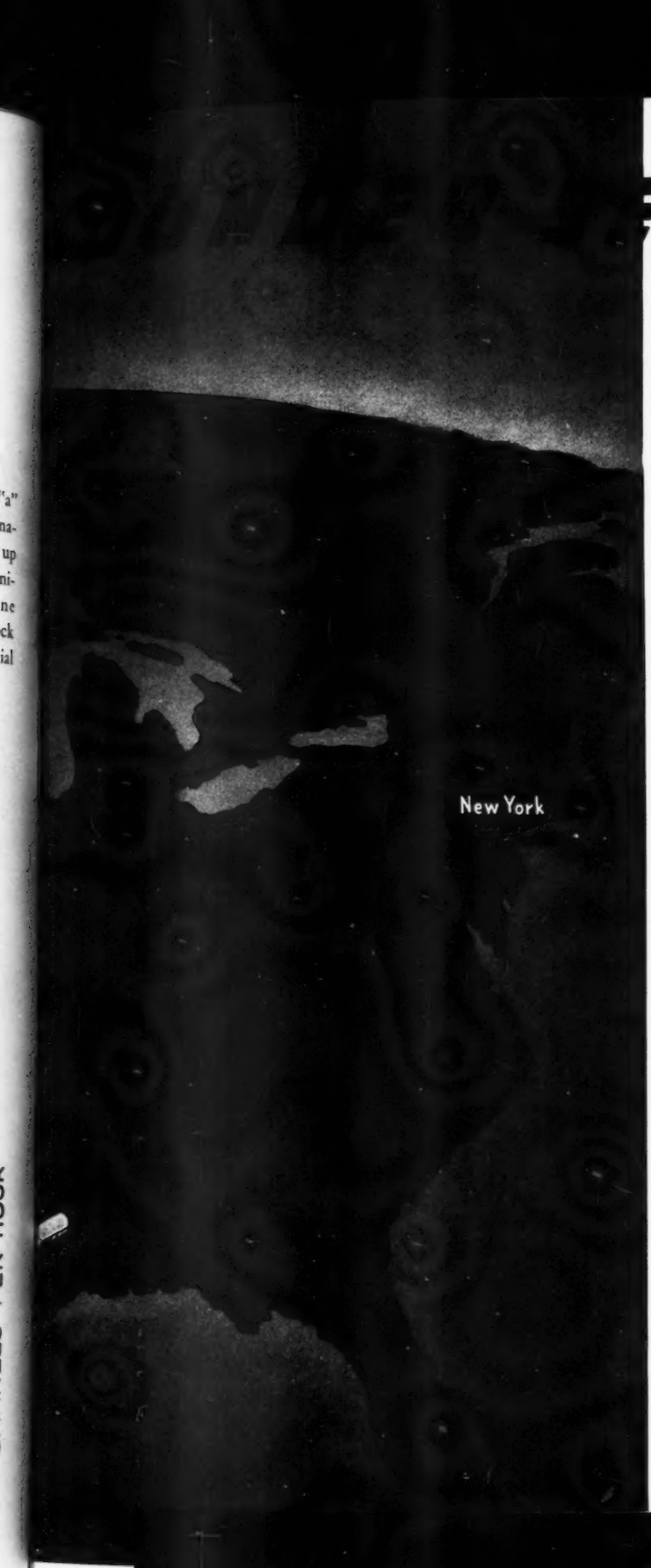
Plunger Pump Displacement and Pump Selection Chart

By FRANK E. HANGS

TO find the displacement of a 5-in. by 10-in. pump, four plungers, 45 r.p.m.: (1) Connect diameter and stroke. (2) Draw line through point "a" and number of plungers. (3) Draw line through "b" and 45 revolutions per minute.

An equally important use of the chart is in selecting a number of bore and stroke combinations for a required speed and displacement. For example, using the setup as given in the first paragraph: 5000 bbl. per day at 45 r.p.m., one can determine point "b". Knowing the number of plungers (as a duplex double-acting pump) one can determine point "a". Using point "a" as a pivot select a number of combinations of bores and strokes by sliding up or down the scales. This use is convenient when one wishes to determine quickly if a pump in warehouse stock will fit or can be made to fit a special situation by changing plunger size.





ERVICE

Today, from headquarters located at strategic points throughout the United States, the Lane-Wells organization is offering straight-to-the-job service—a service well-rounded in every phase of drilling and production. Lane-Wells trucks and Lane-Wells crews are ready, day or night, to bring to every operator the services and tools developed, perfected and proved over the past six years of operation.

Even as the horizon continues to follow a well-rounded line of demarcation, so will Lane-Wells service continue its well-rounded program straight-to-the-job.

TECHNICAL OILFIELD SERVICES

A Modified Hazen-Williams Slide Rule

Formula widely applied by engineers to pipe-line flow problems

By W. E. REA

THE Hazen-Williams formula, even though it does not withstand the rigors of "dimensional analysis" continues to retain its popularity. This formula, slightly modified, is widely applied by engineers to pipe-line flow problems when the fluid handled is one of low viscosity, such as gasoline or water. As originally written the formula is:

$$v = 1.318\ C\ r^{0.63}\ \ s^{0.54} \qquad (1)$$

wherein,

v = Velocity, ft. per sec.
C = Coefficient
r = Hydraulic radius, ft.
s = Slope

As used in gasoline or water pipe-line practice by the oil industry, it is generally written in either of the following forms, or slight modifications thereof:

$$Q = \frac{0.0154\ C\ d^{2.63}\ \ p^{0.54}}{g^{0.54}} \qquad (2)$$

$$\text{or}\quad Q = \frac{0.148\ C\ d^{2.63}\ \ p^{0.54}}{g^{0.54}} \qquad (3)$$

wherein,

Q = Rate of flow, bbl./hr. in formula (2)
Q = Rate of flow, bbl./day in formula (3)
p = Friction loss, lb./sq. in./1000 ft. in formula (2)
p = Friction loss, lb./sq. in./mile in formula (3)
C = Coefficient
d = Internal diameter of pipe in inches
g = Specific gravity of liquid

In (2) and (3), the specific gravity has been introduced by writing:

$$h = \frac{p}{(0.433g)}$$

Users of "exponential" formulae are well aware of the fact that their solution requires more or less tedious and cumbersome calculations. If formulae of this type are used constantly the general procedure has been to design charts or graphs in order to eliminate these long calculations. Williams and Hazen, realizing this difficulty, designed a slide rule for the solution of their formula. Their slide rule is based on formula (1), which was intended for use with water only, and for several reasons it is not readily adaptable to gasoline pipe-line use. In the writer's work, the use of graphs, based on the modified formula, were not satisfactory; furthermore, the number of calculations performed justified the development of a slide rule that would also solve gasoline pipe-line flow problems. These rules, using formula (2) as a basis, are being made by the Keuffel and Esser Company.

Fig. 1 illustrates this rule. It is graduated 10 in. (25 cm.) of its length and has scales on each face, i. e., front and back. The Q, C, d, p, and g scales for the Hazen-Williams formula (2), appear on the face of the rule. The back contains the usual A, B, C, D, and C_1 scales as found on an ordinary Mannheim type rule, these scales being included for ordinary arithmetical calculations only.

In using the rule only three settings are required for finding the value of any member of the equation. The following examples are given to illustrate the use of the rule:

Example No. 1

Determine the capacity Q of a 6.11-in. I. D. pipe line handling gasoline of 0.74 specific gravity, when C is 135, and p is 5.6 lb./sq. in./1000 ft. To 5.6 on p set 6.11 on d, set indicator to 0.74 on g and move index of C to indicator. Opposite 135 on C read 724 on Q. The decimal point is determined by inspection, giving Q equal to 724 bbl. per hour.

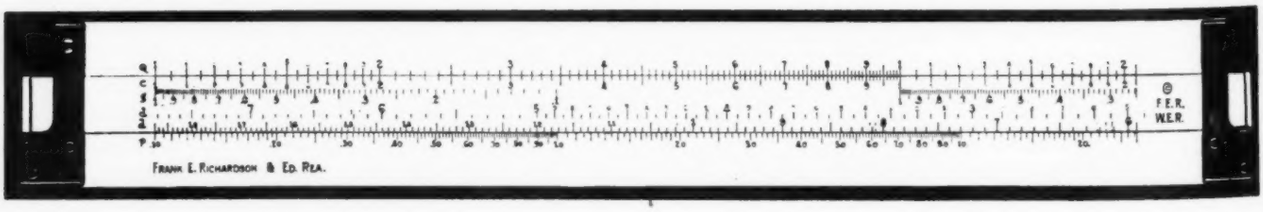
Example No. 2

What will be the pressure drop p through 1000 ft. of 7.98-in. I. D. pipe when Q equals 1500, g equals 0.73, and C is 130? To 1500 on Q set 0.73 on g, move indicator to left index of g, set 130 on C indicator. Opposite 7.98 on d read 6.23 on p.

Example No. 3

What is the value of the coefficient C when Q equals 500, p equals 3.5, g is 0.75, and d is 6.11? To 3.5 on p set 6.11 on d, set indicator to 0.75 on g, move left index of C to indicator. Opposite 500 on Q read 122 on C.

Fig. 1



—and so,

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Accident and expediency brings some trade to any door, but business is usually very careful. It goes where it gets good merchandise and good service.

It has been a long time since this supply business was founded. We know now, as we knew in the beginning, that oil men wanted convenient, friendly and efficient sources of supply for their equipment needs.

We knew, too, that the Petroleum Industry would expect a continuing reliability on the part of their supply source to function in both old and new fields. The adoption of this policy has been one of the contributing factors to our continuing growth.

Today, as our stores and offices are opened for the day's business, every member of our organization is more determined than ever to render that type of service to our customers which will justify the saying, "You'll Do Better at Frick-Reid's."

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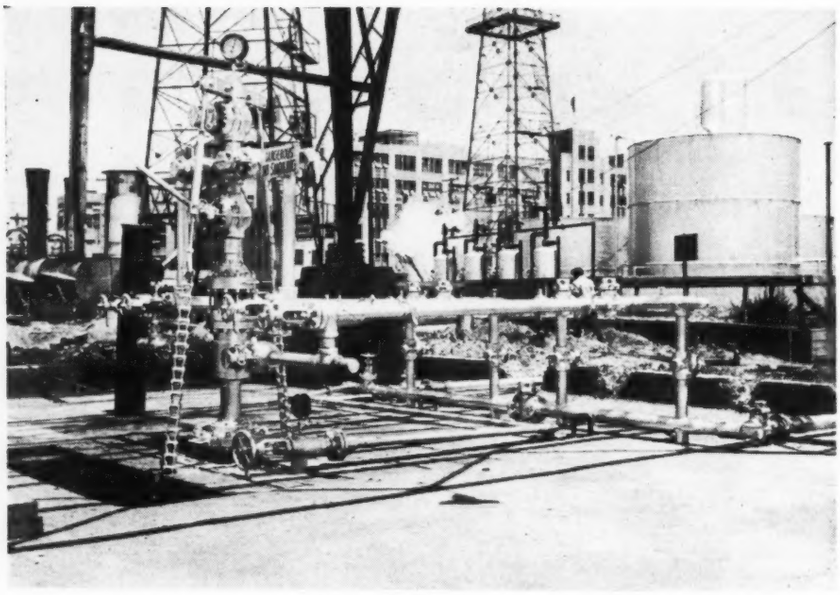


A typical three-zone hook-up illustrating the type of surface equipment used

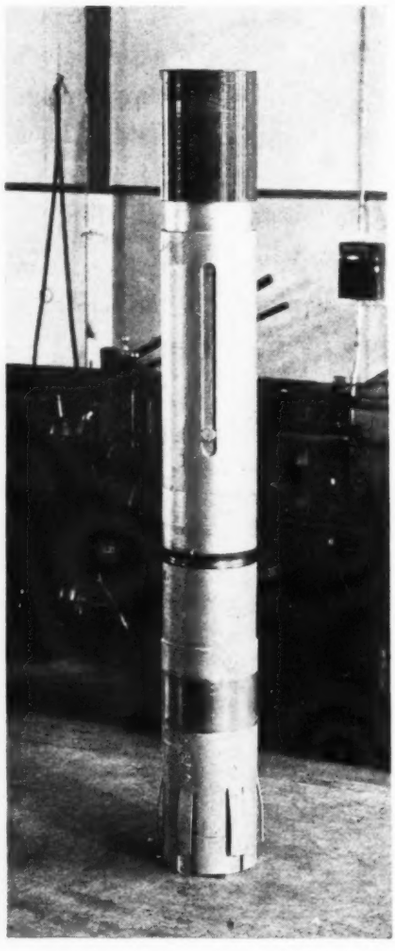
By

Wallace A. Sawdon
Petroleum Engineer,
Los Angeles

Well Equipment and Completion Methods Produced from Different Zones

IN the Long Beach Harbor district of the Wilmington field in California the oil produced from each of the three zones in wells that penetrate all three zones is segregated because of the difference in gravity of the oil, difference in formation pressures, and difference in amount and type of sand accompanying the oil from the different formations. The three sands are the Ranger, Upper Terminal, and Lower Terminal; although there is some question whether the two Terminal zones are truly different formations, in many wells the differences in pressure and character of the oil warrant the segregation of the oil produced from each sand. In some wells, therefore, oil from each of three zones is produced separately and in others oil from two zones is produced separately. This has resulted in the development of special methods of well-completion, which have proved highly successful.

Oil from the Tar zone is produced with that from the Ranger in some other portions of the field, but in this district this zone is usually cased-off with an 11¾-in. water string cemented at its base at a depth slightly exceeding 2500 feet. The oil string consists of liner hung in the water string and in some wells is a full 8⅝-in. string and in others a combination 8⅝-in. and 6⅝-inch. This liner is composed of perforated sections opposite the producing strata and blank sections opposite other formations.



Lead seal packer, run on 2½-in tubing to provide a fluid seal between the liner and the tubing

Production is segregated by cementing behind the liner. A single intermediate cement job thus is sufficient if the well is to produce from the Ranger and Upper Terminal or if production from the Upper and Lower Terminal zones is combined but kept separate from the oil from the Ranger zone. For such a job the cement is placed behind the blank pipe between the Ranger and Upper Terminal zones.

Where oil from each of the three sands is to be kept separate, blank sections of the liner are cemented between the Ranger and Upper Terminal and between the Upper and Lower Terminal zones. In many wells the liner is cemented in three stages as one cementing job is required near the middle of the Upper Terminal zone. (Fig. 1.)

Most companies hang the full liner in the hole and cement the blank sections by stages. In one procedure being followed, a special whirler-ported float collar having a solid baffle is inserted at the bottom of the blank section of pipe that is to be cemented as

the lowest stage and a whirler-ported bridging collar constructed with a seat for a Bakelite ball is inserted at the bottom of the blank section of pipe that is to be cemented as the second stage. After the liner has been hung, tubing or drill pipe is screwed into left-hand square threads in the lower collar and cement pumped down the tubing, through the whirler ports, and upward behind the blank section of liner. The tubing is backed-off and pulled from the hole immediately upon completion of the job. A Bakelite ball is then dropped in the casing to seat in the bridging collar to form a baffle below the cementing ports. A cement retainer is set above the ports and the cement is forced out the ports and around the blank section of pipe. If a third cementing stage is necessary, a cement retainer is set as a bridge plug below ports provided at the bottom of the third blank section of pipe to be cemented, a cement retainer is set just above these ports, and the blank section of liner is cemented.

Another cementing method being used is "series cementing," in which a cement retainer is used in cementing each blank section of liner. Collars equipped with whirler ports are inserted at the bottom of each blank section to provide a passage for the cement and a cement baffle is placed in the liner just below the lowest blank section. A cement retainer is set above the ports provided for the lowest of the series of cement jobs and the cement is pumped through it. A bridge plug is then set below the ports for the next higher job, a cement retainer is set above the ports, and this section of blank pipe is cemented. The third job is performed in the same manner as the second.

The cement retainers now being used are made of "Securaloy," which is a special aluminum alloy that is readily drilled-up. Cementing baskets are placed at the bottom of each blank section of liner and inverted baskets at the top. These are used to protect the producing sands both above and below and to insure return of excess cement into the liner through holes provided for the purpose at the top of the blank pipe.

Another procedure involves the use of the "multiple stage device" made-up in the liner at the bottom of each blank section to be cemented. This device consists of a collar provided with holes covered by clapper valves. These valves are metal disks held in place against the liner by strips of steel spring. As the cement is forced through the ports the valves open and allow the slurry to pass from the pipe and upward around the blank section. When the cementing job is completed the disks return to their position against the liner.

The cement is pumped to the ports through drill pipe on the end of which is attached the lower portion of a perforation washer. During the cementing operation the packing members of the washer are set above and below the cement ports in the liner; the slurry, leaving the washer through openings between the packing assemblies, is forced out the ports in the liner. In some wells the whirler-ported float collar equipped with solid baffle at the bottom as previously described is used for cementing the lowest stage and the upper stages are then cemented by using the multiple-stage device. Cementing baskets also can be used at the top and bottom of each blank section in this method of cementing.

If the holes have not been deviated, some companies are "stacking" the liner when cementing. A section of liner (made-up of perforated pipe on bottom and blank pipe on top) is first run to bottom on the drill pipe. At the bottom of the blank section is a whirler float collar provided with a solid cement baffle below its discharge ports. At the top, the pipe is belled-out for a distance of ten feet. A $6\frac{5}{8}$-in. liner is expanded to a diameter of $7\frac{5}{8}$ inches. The section of liner is equipped with a special adapter and the drill pipe on which it is run is packed-off within the liner.

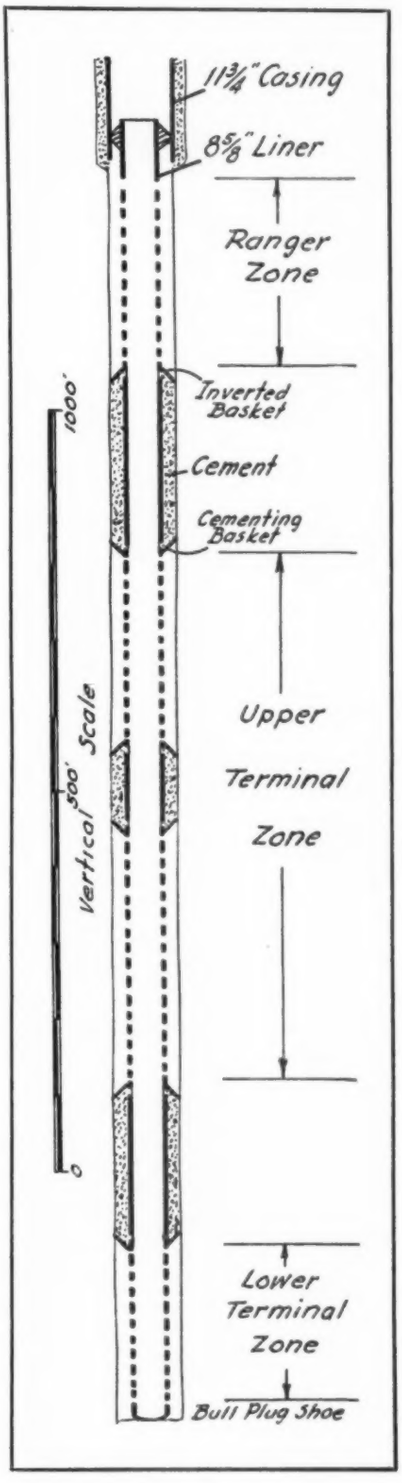
Cement slurry is pumped downward through the drill pipe and forced out the whirler collar. As soon as the job is finished the drill pipe is backed-off and pulled, carrying the packing member with it. After the cement has set the section of liner is cleaned-out.

(*Continued on Page 54*)

Used to Segregate Oils at Wilmington

Differences in characteristics of oil and of producing zones make production through separate flow strings desirable

Fig. 1. Showing the location of the cement around the $8\frac{5}{8}$-in. liner in a typical three-zone completion



Over 70 wells
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Progressive operators everywhere are adopting the modern production techniques made possible by "Securaloy," the new drillable metal, and by the complete line of Security Drillable Products manufactured from it.

In the Wilmington-Long Beach Harbor Field alone over 70 wells have used Security Drillable Products in regular and multiple production work. In other fields the acceptance of these products has been equally outstanding because this equipment puts completely new production efficiencies within reach.

By methods never before feasible you can get more from your development dollar... obtain greater oil production at less cost... and safeguard your oil well investment with subsurface equipment that can be used the same as steel, yet can be completely drilled up whenever necessary!

SECURITY DRILLABLE PRODUCTS

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Get the complete details on these Security Products today. Learn how you can lengthen the producing life of your wells . . . how you can leave drillable windows in your casing to aid subsequent development operations . . . how you can efficiently seal off water and gas zones in old producing zones . . . or, if formations are favorable, how you can adapt multiple production methods to **your** wells. Our engineering staff will gladly work with you on your particular problems. No obligation, of course.

"SECURALOY"

"Securaloy" is the drillable metal developed by Security engineers **especially for oil field use.**

★ It is Strong, having strength factors that compare favorably with those of steel.

★ It has High Erosion and Corrosion resisting qualities, with unusual resistance to sulphur compounds and other corrosive chemicals commonly found in oil wells.

★ It has Low Specific Gravity, the cuttings readily circulating out of the hole with the drilling fluid.

★ And, above all, **it is Drillable!**

And here's an important point. The drillable feature of "Securaloy" has led some to believe that it is primarily a metal for testing production possibilities only. "Securaloy" **is** used extensively for safely testing new zones. Then, if the zone proves barren, it is drilled up to allow deeper exploration. But its most important role is the **permanent protection** it affords your wells. It can be left in the hole indefinitely the same as conventional equipment, and used for regular production work. Think of the efficiency and permanent protection this feature provides!

"Securaloy" is manufactured into Security Drillable Liners and Blank Pipe (supplied in a wide range of sizes), and into a complete selection of drillable subsurface items, such as Bull Plugs, Adapters, Collars, Reducers, Subs, etc. to meet all production needs.

...ome field prove that-
...RLABLE PRODUCTS
...OPMENT EFFICIENCIES!

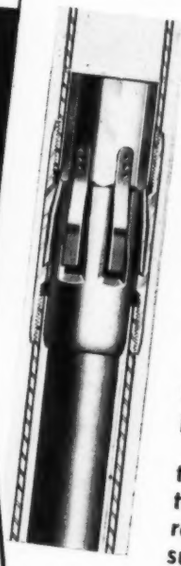
SECURITY LEAD SEAL PACKER

This Packer is used extensively in multiple production work. There are no slips to jam, and it requires no twisting or turning to set. It has springs that pass freely through casing couplings but catch **automatically** in the specially-formed recess of a Hook Collar placed at the desired point in the casing string. This locks the tool against further downward travel and expands the Lead Packer to form a fluid-tight seal between the outer and inner string.

A special Security Circulating Joint can be run above the Packer, if desired, to provide an easily opened valve between the inner and outer strings for bringing in the well. Raising the run-in string opens two ports in the side of the Joint—lowering it closes them. A Lead Seal automatically makes the Joint fluid-tight in the closed position.

Both the Packer and Circulating Joint are particularly adapted to drillable construction as everything except the short spring fingers can be made of "Securaloy." Also supplied in conventional steel construction, if desired. A full range of sizes and types to fit every casing string is available.

SECURITY HOOK-COLLAR LINER HANGER



This is a radically different type of Liner Hanger that has no slips to jam, and nothing to twist or turn when setting. It eliminates danger of setting the Liner too high, or too low, in the hole and is always reliable. It utilizes the same efficient spring and recessed-collar principle as the Lead Seal Packer (at left) and will carry the heaviest liner loads without strain. Just run it in the hole. It sets **automatically** when it reaches the specially shaped recess of the Hook Collar. A straight pull instantly releases it!

The Hook Collar Liner Hanger is manufactured both of "Securaloy" Drillable construction and regular steel construction in a full range of sizes. Special Hook Collars can be supplied for **all** types of casing and threads!

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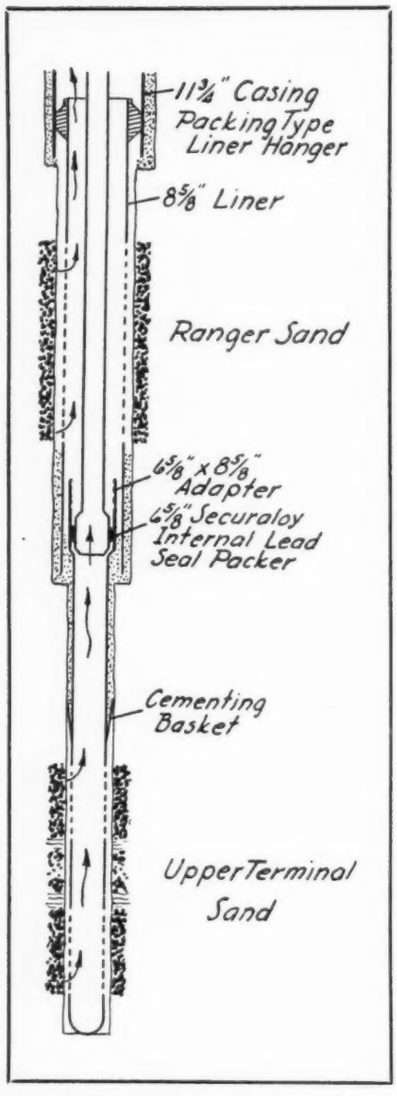


Fig. 2. Procedure used in completing some two-zone wells

(*Continued from Page 51*)

The next section, similarly made-up of perforated and blank pipe, is then run into the hole on the drill pipe and enters the enlarged top of the section already cemented. At the bottom of the enlarged portion of pipe is a lead seal or a beveled seat on which the upper section of liner rests. This second section is then cemented in the same manner as the first. If a third section is required the operation is repeated.

Two-Zone Completions

When a well is drilled through the Ranger and the Upper Terminal and production from only these two zones is to be segregated, the liner is run and cemented between the sands as described. Tubing is packed-off at some point between the perforated sections of the liner and the oil from the Terminal flows through the tubing and that from the Ranger through the annular space between the tubing and the liner.

In completing some two-zone wells, however, the procedure illustrated by Fig. 2 is followed. Hole is first drilled through the Ranger and 8⅝-in. liner perforated opposite the productive stratum is hung in the 11¾-in. water string. The hole is then drilled through the Upper Terminal and 6⅝-in. perforated liner of sufficient length to extend above the shoe of the 8⅝-in. liner is run to bottom. The upper, blank section of the 6⅝-in. liner is cemented, the cement being extended into the 8⅝-in. string to bond the two strings.

At the top of the 6⅝-in. liner is a special "Securaloy" adapter into which an internal-lead-seal "Securaloy" packer is run on 2½-in. tubing to provide a fluid seal between the liner and the tubing.

Three-Zone Completions

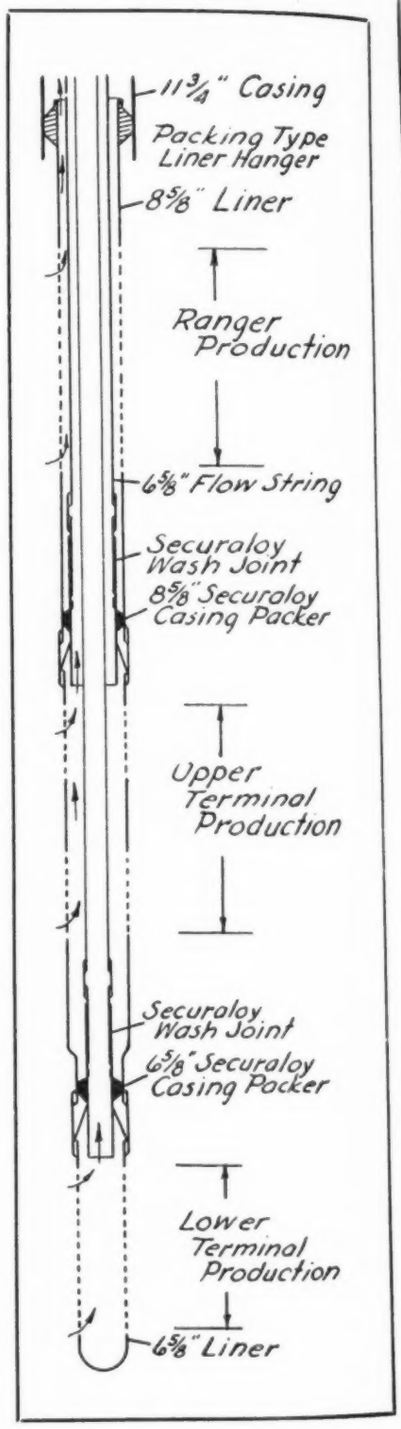
In general, the production from three zones is segregated by running a flow string into the well and packing-off within the 8⅝-in. liner below the perforations opposite the Ranger sand. Tubing is then run and packed-off below the perforations opposite the Upper Terminal zone. Oil from the Lower Terminal zone is thus produced through the tubing; that from the Upper Terminal through the annular space between the tubing and flow string, and that from the Ranger through the annular space between the flow string and the 8⅝-in. liner. Details of the equipment used in completion using a full 8⅝-in. liner and using a combination 6⅝-in. and 8⅝-in. string are shown in Figs. 3 and 4.

The combination string illustrated in Fig. 3 is suspended in the water string by a packing-type liner hanger. The 8⅝-in. pipe extends through the Ranger and Upper Terminal sands and 6⅝-in. through the Lower Terminal. The segregation of the zones by cement behind the blank sections of pipe is indicated in Fig. 1.

A 6⅝-in. flow string is run and packed-off between the Ranger and Upper Terminal zones. This string preferably includes flush-joint pipe at the bottom sufficient to extend above the top of the 8⅝-in. liner and thus provide maximum clearance between the two strings. On the bottom of the flow string is a special "Securaloy" packer and wash joint. The packer is set at the predetermined point in the 8⅝-in. liner and forms a seal between the liner and the flow string. The inside diameter of the packer is the same as that of the 6⅝-in. pipe so there is no restriction of the annular space between it and the tubing.

The tubing is 2½-in. upset and is equipped near the bottom with a packer and wash joint like that used on the flow string. This packer is set in the 6⅝-in. section of the liner between

Fig. 3. A combination string suspended in the water string by a packing-type liner hanger, in a three-zone completion



the Upper and Lower Terminal zones. As shown in Fig. 4, both a casing packer and internal lead seal packer are necessary for packing-off the tubing in a full 8⅝-in. string. The casing packer is, of course, set before the flow string is packed-off and it has an inner shoulder that provides a means of setting the packer on the tubing when it is run after the flow string has been packed-off.

The telescoping wash joints above the packer not only provide a means of circulating between any two strings of pipe for removal of sand and other foreign matter but also can be used to induce the flow of oil when bringing-in the different zones. They offer the further advantage of future use as return flow ports if one or more sands are placed on gas-lift.

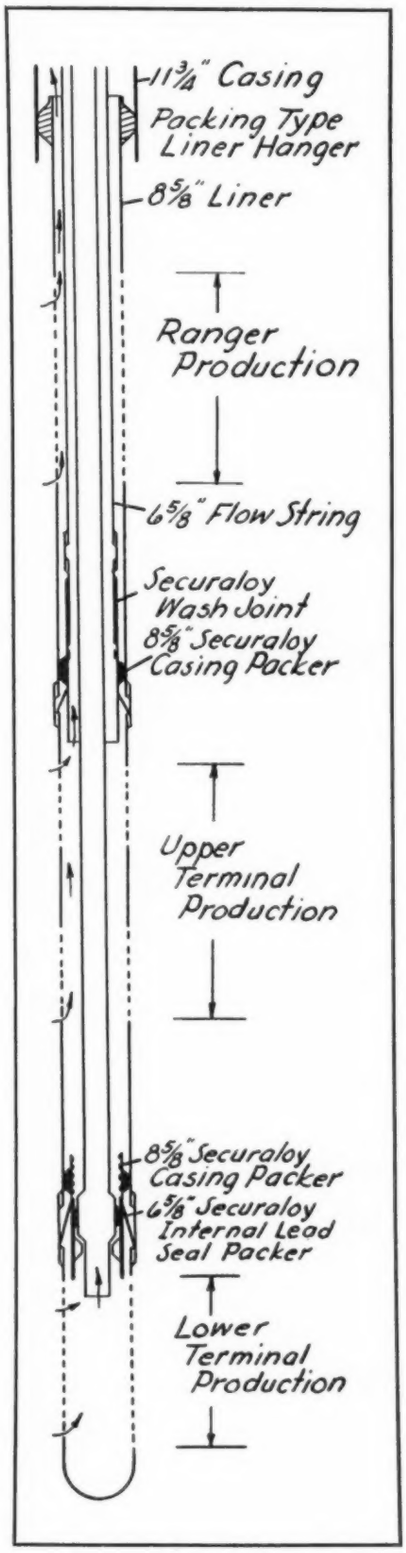
These joints consist of two concentric tubes. Two lugs on the inner tube allow a vertical movement within the limits of slots in the outer barrel and hold the tubes in position. Left-hand threads connect the inner tube to a sub above and the outer barrel to the packer below. The lower end of the inner tube rests on a lead packing ring in the bottom of the outer barrel when the joint is closed. Raising the pipe raises the inner tube and opens the seal, creating a fluid by-pass directly above the packer body. A rise of four in. will uncover the slots in the outer barrel and permit the passage of fluid. When the pipe is again lowered the ports are closed.

Induction of Flow

When utilizing the wash joints to bring-in production, some operators first induce flow from the Ranger sand by raising the 6⅝-in. flow string until the ports are open. (Fig. 3.) Circulation is then established down the flow string, out the wash-joint ports, and upward between the flow string and the 8⅝-in. liner. As soon as natural flow from the Ranger has thus been started, the flow string is lowered to confine the production to the annular space around the flow string.

The tubing is then raised to open the wash-joint ports above its packer and circulation is established through the ports either normally down the tubing or down the annular space between the tubing and the flow string. Generally both the Upper and Lower Terminal zones are brought-in by this operation and the tubing is then lowered to segregate the flows from the two sands. Should only the Lower Terminal be brought-in, the tubing can then be raised to allow the fluid to pass through the ports and upward past the perforations opposite the Upper Terminal to induce flow from this formation.

Fig. 4. Details of the equipment used in a three-zone completion using a combination 6⅝-in. and 8⅝-in. string



Sometimes the Lower Terminal is brought-in first, the tubing is raised and this oil passed through the wash ports to induce flow from the Upper Terminal, and the tubing is then lowered and the flow string raised to allow the oil from the Upper Terminal to pass through the flow string ports and wash-in the Ranger zone. The flow string is then lowered and the oil is produced from each sand separately.

Surface Equipment

Special casing and tubing landing heads have been developed to produce continuously oil of different gravity from different zones through separate flow strings and a common Christmas tree. A typical three-zone hook-up is illustrated to show the type of surface equipment employed. (Page 50.)

The 6⅝-in. flow string is landed in a specially-designed head in which the spider and slips rest on a split Neoprene packing unit. As the string is lifted when the wash-joint ports are opened for circulating, leakage is prevented by a stripper assembly immediately below the packing unit. The flow string is stripped-in through this assembly and landed on the packing unit above. The pipe can thus be raised and lowered under well pressure without leakage or danger.

The tubinghead of similar design permits raising and lowering of the tubing string. There is a 6-ft. sleeve at the top of the tubing around which the packing and stripper are fitted. The I.D. of this sleeve is the same as that of 2½-in. tubing but the O.D. is that of 2½-in. couplings. The sleeve gives rigid support to the Christmas tree.

The high-pressure swivels generally used in the flow lines permit movement of the tubing without necessity for disconnecting the Christmas tree. Flow is regulated by adjustable flow beans; because of the severe sand cutting, the chokes and tips are made of an alloy of great resistance to abrasion.

Application of the Gas Laws to Gasoline Plant Calculations

Probable yield, quality of product, and optimum operating conditions computed from analysis of gas

By R. H. TURNER

THE composition of the paraffin hydrocarbon series, which constitutes all natural gasolines, is expressed by the general formula C_nH_{2n+2}, and the series includes:

1. Methane ..... CH_4
2. Ethane ..... C_2H_6
3. Propane ..... C_3H_8
4. Butane ..... C_4H_{10}
5. Pentane ..... C_5H_{12}
6. Hexane ..... C_6H_{14}
7. Heptane ..... C_7H_{16}
8. Octane ..... C_8H_{18}
9. Nonane ..... C_9H_{20}

Ordinarily the fractional analysis of a gas or gasoline includes the percentage of each fraction to pentane and the rest is lumped as hexane+, or it includes individual compounds to butane and the rest is lumped as pentanes+. This is satisfactory, as no appreciable error is introduced into any calculations by regarding the heavier fractions as one unit.

In many gases there are certain "iso-fractions", such as iso-propane, iso-butane, and iso-pentane; these constituents closely resemble the normal compounds of the same name and empirical formula. These iso-fractions differ only slightly in vapor pressure, number of cu. ft. per gal. of liquid, and in certain other characteristics from the commonly known fractions and ordinarily no appreciable error is introduced in the design of a plant if they are regarded as being the same as the normal compounds. They should be included, however, in the low-temperature fractional analysis of a gas or gasoline; and in calculations of designs and operations, they should be regarded as separate fractions.

The characteristics of the paraffin hydrocarbon series were shown in Table P771.2, January, 1938, issue of *The Petroleum Engineer*, page 129.

Before much can be said or understood concerning these compounds, something must be known concerning the behavior of gases under certain conditions of temperature and pressure; a summary of the basic laws governing the behavior of perfect gases follows. The gases in question conform to these laws sufficiently closely that no appreciable error is introduced by regarding them as perfect gases.

Boyle's Law: At constant temperature, the volume of a gas is inversely proportional to its absolute pressure, or

$$PV = \text{a constant.}$$

In other words, doubling the absolute pressure on a given amount of gas would halve its volume.

Gay-Lussac's Law: If the temperature of a given amount of gas be raised the gas will expand or its pressure will increase. It has been found that at 0 deg. cent., raising the temperature one deg. cent. will cause a gas to increase in volume by 1/273 of its volume, at constant pressure. Conversely, the pressure will be increased by 1/273 at 0 deg. cent., if the gas is heated at constant volume.

Absolute Zero: Inasmuch as the volume of gas diminishes by 1/273 of its volume at 0 deg. cent. for each degree it is cooled, when the gas has been cooled to minus 273 deg. cent. its volume should be zero; minus 273 deg. cent. is known as the absolute zero. In English units, this corresponds to minus 459.6 deg. fahr., usually stated in round figures as minus 460 deg. fahrenheit. This constant reduction of volume characterizes a perfect gas; it has been found that actual gases condense to liquids before this temperature is reached.

The pressure and temperature effects on a gas can be more comprehensively shown by the following equation:

$$PVT' = P'V'T$$

P = Initial absolute press., lb./sq. in.
V = Initial volume, cu. ft.
T' = Final absolute temperature (deg. fahr. + 460).
P' = Final absolute pressure, lb./sq. in.
V' = Final volume, cu. ft.
T = Initial absolute temperature (deg. fahr. + 460).

Example: The volume of a certain gas is 12,000,000 cu. ft. at 14.67 lb. abs. (0 lb. gauge) and 32 deg. fahr. (492 deg. fahr. abs.). What will its volume be at 29.67 lb. abs. (15 lb. gauge) and 100 deg. fahr. (560 deg. fahr. abs.)?

$$V' = 12{,}000{,}000 \times 14.67/29.67 \times 560/492.$$

$V' = 6{,}753{,}310$ cu. ft.

Molal Volume of Gases: The volume occupied by one gram molecular weight of a gas at 0 deg. cent. and at atmospheric pressure may be found as follows:

$$1 \times V = 1 \times 0.08207 \times 273.$$
$$V = 22.41 \text{ liters.}$$

In the same way the value of the mol may be found in English units and has been found to be 359.0 for one lb. mol of a gas at standard conditions (32 deg. fahr. and 14.67 lb. pressure). In other words, 359 is the exact number of cu. ft. of a gas under standard conditions of temperature and pressure that will weigh the number of lb. corresponding to the molecular weight of the gas.

Dalton's Law: When gases are mixed, it has been found that each gas exerts exactly the same pressure as it would if that same amount of that gas alone occupied the same space under like conditions of temperature and pressure, and that the total pressure exerted by the mixture of the gases is equal to the sum of the individual pressures of each of the gases. The pressure of each of the individual gases is known as its partial pressure and the combined pressure of all the gases the vapor pressure of the composition. This law is known as Dalton's Law of Partial Pressures.

Inasmuch as the volume of one mol of every gas must be the same at the same temperature and pressure, it is therefore evident from Dalton's Law that the partial pressure of a gas in a mixture of gases bears the same ratio to the total pressure that the number of mols of the gas bears to the total number of mols of all the gases present. This ratio is called the mol-fraction and the rule may be stated:

$$p = Px$$

p = partial pressure of the gas in the mixture of the gases.

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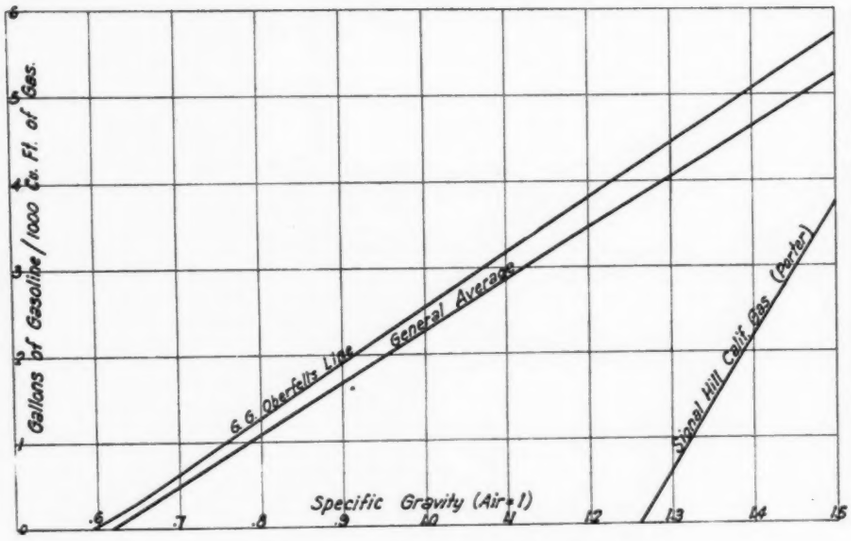


Specific gravity and gasoline content of casinghead gas

x = mols of the gas per mol of the mixture.

P = total pressure of the mixture.

Example: The composition of air is as follows: 20.9 percent oxygen, 78.1 percent nitrogen, and 1.0 percent argon, by volume. Therefore, at 760 mm. (14.67 lb.) pressure, the partial pressure of the oxygen will be:

$20.9/100 \times 760 = 159$ mm.

The partial pressure of the other constituents can be found in a similar manner. Furthermore, the partial pressure of any gas in a mixture of gases can be found when pressure and composition are known.

The percentages of constituents of gases in a mixture are usually given in volume percent, which for gases is the same as mol percent, and frequently it is desirable to convert to weight percentages, or vice versa. This procedure is shown by the following example:

Calculation of Weight Percent

The molecular weight of $O_2 = 32.00$
The molecular weight of $N_2 = 28.02$
The molecular weight of Argon $= 39.88$

In 100 mols of air the weights are:

O_2	$20.90 \times 32.00 =$	668.8
N_2	$78.10 \times 28.02 =$	2189.0
Argon	$1.00 \times 39.88 =$	39.88
		approx. 2898.0

Weight percent $O_2 =$
$668.8/2898 \times 100 = 23.1$
Weight percent $N_2 =$
$2189.0/2898 \times 100 = 75.5$
Weight percent Argon =
$39.88/2898 \times 100 = 1.38$

Calculation of Mol Percent

What is the mol percent of acetone and ethyl alcohol in a vapor containing equal parts by weight of each?

M. wt. alcohol $(C_2H_5OH) = 46.06$
M. wt. acetone $(CH_3)_2CO = 58.07$

In 100 parts of the mixture, the mols of vapor will be:

$50/46.06 = 1.110$ mols of alcohol
$50/58.07 = 0.860$ mols of acetone

1.970

Mol percent alcohol =
$1.110/1.97 \times 100 = 56.30$
Mol percent acetone =
$0.860/1.97 \times 100 = 43.70$

100.0

Raoult's Law: The vapor pressure of a liquid is lowered by the introduction of a dissolved substance, or solute. It has been found that the vapor pressure is reduced proportionally to the mol-fraction of the dissolved substance. This is known as Raoult's Law of Vapor Pressure Lowering. It can be predicted qualitatively from the Phase Rule, as the addition of another substance to a pure liquid forms a two-component system, and it is, therefore, necessary to fix the composition of the liquid (or the vapor) as well as the temperature, in order to fix the vapor pressure.

Henry's Law: Another rule for solutions is Henry's Law, which states that the partial pressure over the mixture of a volatile solute dissolved in a solvent is proportional to the mol-fraction of the solute in the mixture.

Avogadro's Law: This law states that equal volumes of all gases contain the same number of molecules. It follows from this law that the pressure exerted by a gas at a given temperature is proportional to the number of molecules of that gas per unit of volume.

Low Temperature Fractional Analysis

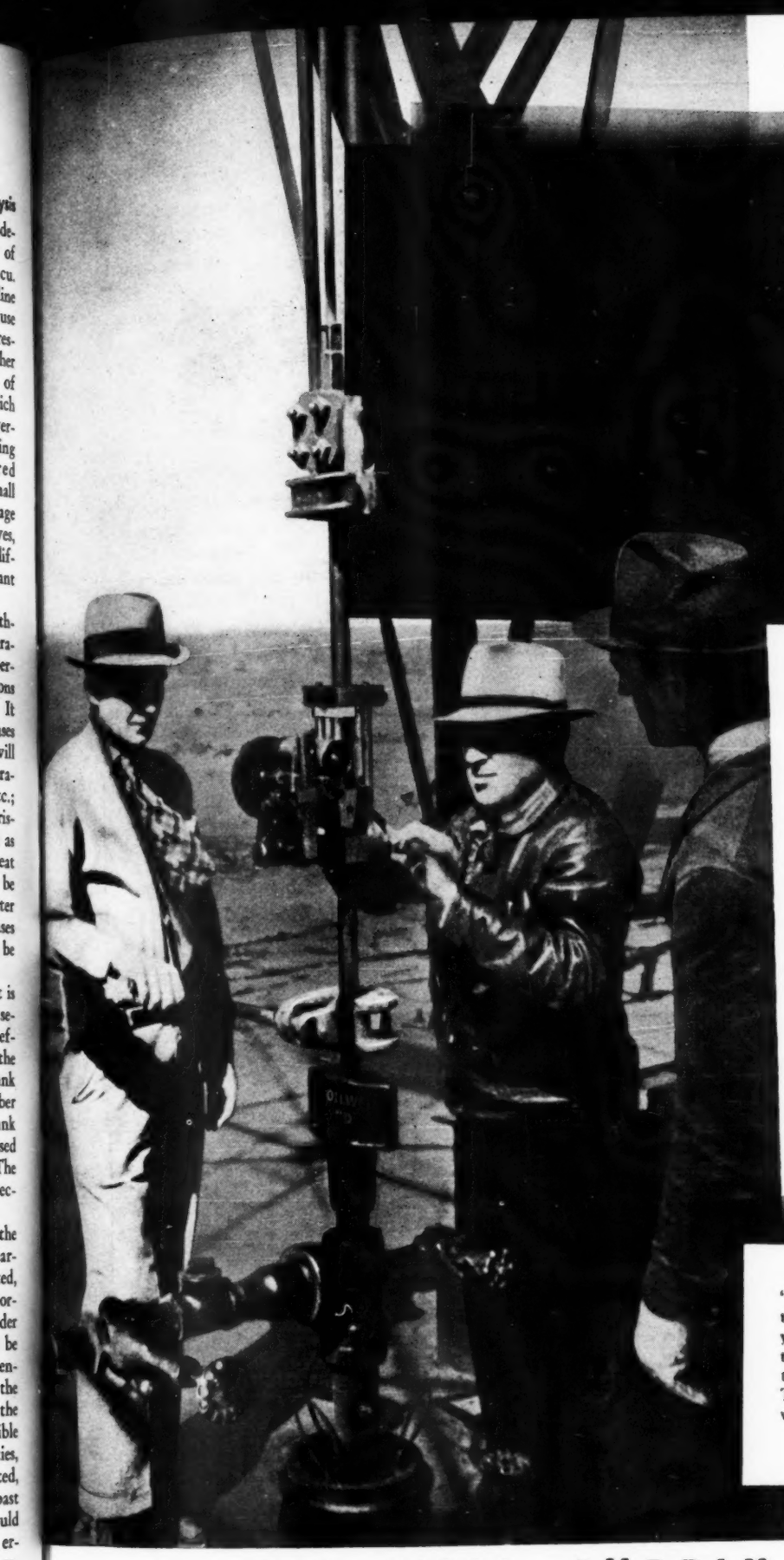
For years gasoline plants were designed on the basis of the number of gal. of gasoline per 1000 standard cu. ft. of gas being treated. This gasoline content was determined either by use of the charcoal method or compression car. This information, together with data concerning the amount of gas to be treated, pressure at which the absorbers were to be operated, average weather conditions affecting water-cooling, etc., was considered sufficient. Considering the small amount of information the average charcoal test or compression test gives, it is surprising that more serious difficulties were not encountered in plant design and operation.

No plant should be designed without first determining by low-temperature fractional analysis the mol percentages of the hydrocarbon fractions in the average gas to be treated. It should be remembered that the gases to be treated in the average field will vary materially with the gas/oil ratio, pressure on separators, source, etc.; nevertheless, the average characteristics of the gas should be determined as closely as possible without too great an original expenditure. It should be remembered, however, that the greater the difference in the individual gases to be treated the more tests will be necessary to gain this knowledge.

With this information available it is then possible to design a plant and select equipment of the maximum efficiency. Without this information, the required size for flash and surge tank vent lines, reabsorber size, reabsorber lean oil circulation, size of stock tank vent gas lines, etc., can only be guessed with a fair degree of accuracy. The same is true with respect to the selection of instruments and controls.

Without an analysis of the gas, the fractional amounts of the hydrocarbons absorbed cannot be calculated, and, lacking this information, the correct and economical pressure under which the fractionating still should be operated to yield the required condensate cannot be calculated, nor can the steam consumption for stripping the oil be learned. It is, of course, possible to approximate the above quantities, but if the gas is peculiarly constituted, these approximations based upon past performance of average plants would no doubt tend to introduce serious errors. This is particularly true with regard to determination of the economical absorber pressure and lean oil rate, two factors that are interdependent and that determine the capacity of any absorption plant.

In designing a plant, particularly a compression unit, the specific gravity



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of the gas should be accurately known. The gas is usually tested by the gravity-balance method; however, if the gasoline content of a gas is known the specific gravity can be determined satisfactorily by the accompanying curve. These values, as shown, are not always accurate but the writer has used this curve for years for many different types of gases and has not experienced any appreciable difficulty. The curve has also been checked many times with results obtained by the gravity-balance method and no serious difference has been found.

The specific gravity of a gas is usually expressed relative to air as 1.0. One cu. ft. of air at standard conditions of pressure and temperature weighs 0.0762 lb.; therefore a gas having a specific gravity of 0.65 will weigh:

$$0.0762 \times 0.65 = 0.04953 \text{ lb.}$$
per standard cu. ft.

Example: 15,000,000 standard cu. ft. of gas per 24 hours is being treated by a certain plant. The gravity of the gas is 0.72. Calculate the number of lb. of the gas passing.

$$15{,}000{,}000 \times 0.720 \times 0.0762 = 822{,}960 \text{ lb.}$$

Mol Percent the Same as Volume Percent

As has been stated, the constituents of a gas are usually stated in mol percentages and the mol percentages of gases are the same as volume percentages.

Below is given the low-temperature fractional analysis of a particular high-pressure gas:

Constituent	Percent by Volume
Methane	97.20
Ethane	1.30
Propane	0.60
Butane	0.40
Pentanes	0.50
	100.00

If 10,000,000 standard cu. ft. per 24 hours were being treated the following volumes of the fractions would comprise the total:

Methane	10,000,000 × 0.972 =	9,720,000 cu. ft.
Ethane	10,000,000 × 0.013 =	130,000 cu. ft.
Propane	10,000,000 × 0.006 =	60,000 cu. ft.
Butane	10,000,000 × 0.004 =	40,000 cu. ft.
Pentanes	10,000,000 × 0.005 =	50,000 cu. ft.
		10,000,000 cu. ft.

To Determine Gallons of Gasoline Per 1000 cu. ft. of Gas

To determine the gallons of salable gasoline in 1000 standard cu. ft. of gas a number of factors must be considered. In the ordinary finished stabilized gasoline there is no methane, ethane, or propane, or the quantity of the last is so small as to be negligible. The vapor pressure of gasoline containing an appreciable amount of propane would of necessity exceed the 26-lb. pressure limitation of grade. The finished gasoline ordinarily will contain pentanes plus in amounts of 55 to 60 percent of its volume, and 40 to 45 percent butanes. In other words, in 10,000 gal. of finished gasoline, 5500 to 6000 gal. will be the pentanes plus of the gas and 4000 to 4500 gal. will be the butanes.

The cu. ft. of vapor per gal. of butane is 32.5 and that of pentane 27.3.

Constituent	Mol percent	Cu. ft. per 1000 cu. ft. of gas	Cu. ft. per gal. of liquid	Gal. per M cu. ft. of gas
Methane	97.20	972	.....	.....
Ethane	1.30	13	.....	.....
Propane	0.60	6	.....	.....
Butane	0.40	4	32.50	0.123
Pentanes	0.50	5	27.30	0.183
				0.306

The 0.183 represents 60 percent by volume of the finished gasoline, therefore, $X \times 0.60 = 0.183$, wherein X is the total gal. per M.

$$X = 0.183/0.60 = 0.305$$

Then, $0.305 - 0.183 = 0.122$ gal. per M of butanes in the gasoline.

Therefore, if 20,000,000 standard cu. ft. of gas were being treated, the yield would be:

$20{,}000 \times 0.306 = 6100$ gal. gasoline.

It can readily be seen that in order to produce the maximum amount of gasoline when treating the above gas, it would be necessary to absorb in the mineral seal oil all the butanes available in the gas. In other words, every gal. of butane that was not absorbed would be a gal. of product lost. This is a peculiar condition, as under almost all ordinary circumstances there will be an excess of butanes available in the gas. Consequently, it would not be necessary to absorb all the butanes. As previously stated, the analysis is that of a high-pressure gas.

As a more fitting example, the analysis of a low-pressure casinghead gas is given:

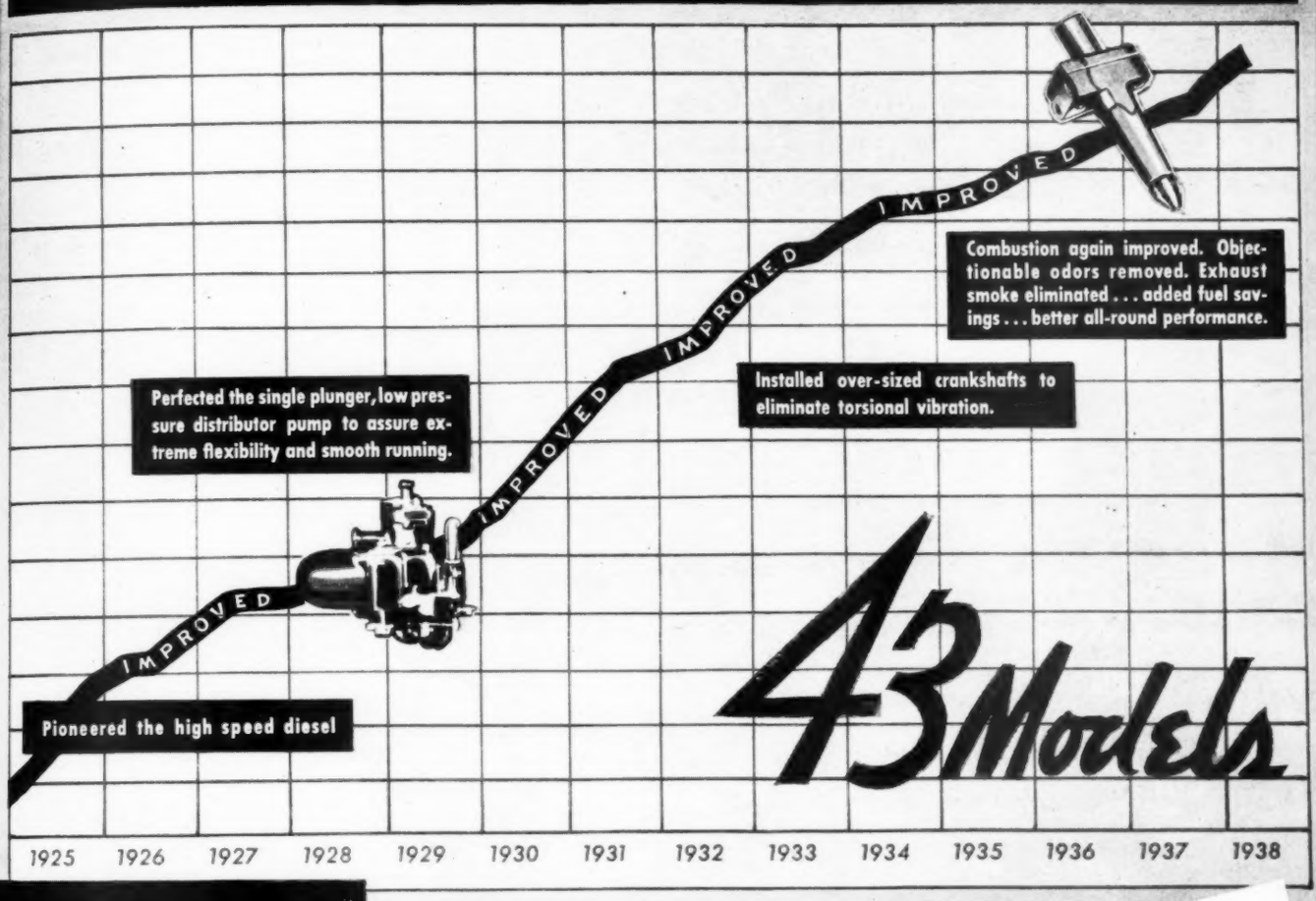
Constituent	Mol percent	Cu. ft. per 1000 cu. ft. of gas	Cu. ft. per gal. of liquid	Gal. per M cu. ft. of gas
Methane	79.60	796	.....	.....
Ethane	10.20	102	.....	.....
Propane	5.70	57	.....	.....
Butane	2.70	27	32.50	0.83
Pentanes	1.80	18	27.30	0.66

$$X \times 0.60 = 0.66;$$
$$X = 1.10 \text{ gal. per M.}$$

Therefore, butanes in the finished product equal $1.10 - 0.66 = 0.44$ gal. per M.

Consequently, only 53 percent $(0.44/0.83 = 0.53)$ of the butanes available in the gas could be included in the finished product because of vapor pressure limitations. Ordinarily a larger percentage of the butane would be absorbed by the mineral seal oil while absorbing 100 percent of the pentanes plus in the gas, but this will be discussed in a later article.

No Recession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Speeding the Construction of Pipe Lines

By GEORGE SYKES*

HIGHER quality welds, increase in speed of welding amounting to 25 percent or more, and a reduction in gas consumption of at least 25 percent are now made possible by two outstanding developments in the welding of overland pipe lines by the Lindeweld method of oxy-acetylene welding. These two developments are: (1) new 4- and 6-flame tips for position welds and rolling welds, respectively, and (2) a new low-alloy steel welding rod.

Although the oxy-acetylene welding of pipe lines was introduced before the World War, it was not until 1930 that the technique now widely employed was first introduced. This process involved the use of backhand welding, a special flame adjustment, and a special welding rod.

This was followed in 1934 by the development of a 3-flame tip designed especially for making rolling welds, which further speeded the welding of pipe lines. In addition to the main welding flame, this tip had two smaller auxiliary flames so placed as to preheat the vee directly ahead of the point of welding. Savings exceeding 25 percent in rods and gases and 30 percent in welding time were effected by the use of this multi-flame tip, as compared with single-flame welding.

The success of the 3-flame tip led quite naturally to investigation of the possibilities of other multi-flame tips for making position or bell-hole welds, as well as for making rolling welds. This investigation, spurred by the recent popularity of the all-bell-hole method of construction, resulted in the development of two new tips—a 4-flame tip for position welds and a 6-flame tip for rolling welds.

All-Bell-Hole Method

The all-bell-hole method consists in assembling the line, a length at a time, and making all welds in position, that is, making them as bell-hole welds. What it really amounts to is the elimination of the usual line-up and firing-line gangs, the bending or tie-in gang handling sections 40 ft. long instead of the usual 200 feet. This method also eliminates dollies and other devices for rolling pipe.

The procedure usually followed is to line-up the pipe on skids over the ditch, after which the joints are tack-welded and then welded without turning the pipe. Besides the tacker, three to six or more operators do the bell-hole welding, the number depending on the speed with which the pipe is lined-up.

Variations of the bell-hole method include the so-called "stab-on" and "stove-pipe" methods, which are commonly used on short lines. Also, there has been developed during the last year a new procedure known as the "one-third roll" method, which has been used with considerable success on a number of recently-completed lines. This method will be discussed later in connection with the construction of a 16-in. gas line.

In spite of its inherent advantage of simplified organization, the all-bell-hole method requires somewhat more time for making the joint than is required for making a rolling weld; however, the introduction of the new 4-flame tip and welding rod makes it possible to produce a bell-hole weld in about the same time that it formerly took to make a rolling weld using a 3-flame tip. For example, on 16-in. diameter pipe having ¼-in. wall thickness, an operator can complete one of these position welds in 8 to 12 minutes. This is an average of about five linear in. of welding a minute, and it is readily apparent that at this speed, the advantages and savings resulting from the all-bell-hole method of construction can now be fully realized.

Four-Flame Tip for Position Welding

In addition to the main welding flame, the 4-flame tip provides two flames for preheating the vee and a fourth flame for preheating the rod. The jet for the rod preheat is so situated that the operator has control of the amount of rod preheated and melted regardless of the point of welding. The two flames for preheating the vee are placed similarly to those in the 3-flame tip.

The 4-flame tip is designed in two sizes—the smaller for pipe wall thicknesses from ¼ in. to 9/32 in., and the larger for thicknesses from 5/16 in. to ⅜ inch.

Welding Technique—Four-Flame Tip

No special technique is required when making position welds with the 4-flame tip. The manipulation of the blow-pipe is essentially the same as that employed when welding with either a single-flame or 3-flame tip. Operators proficient in the Lindewelding technique will have no difficulty using the 4-flame tip, although they will find it necessary to proceed at a faster rate.

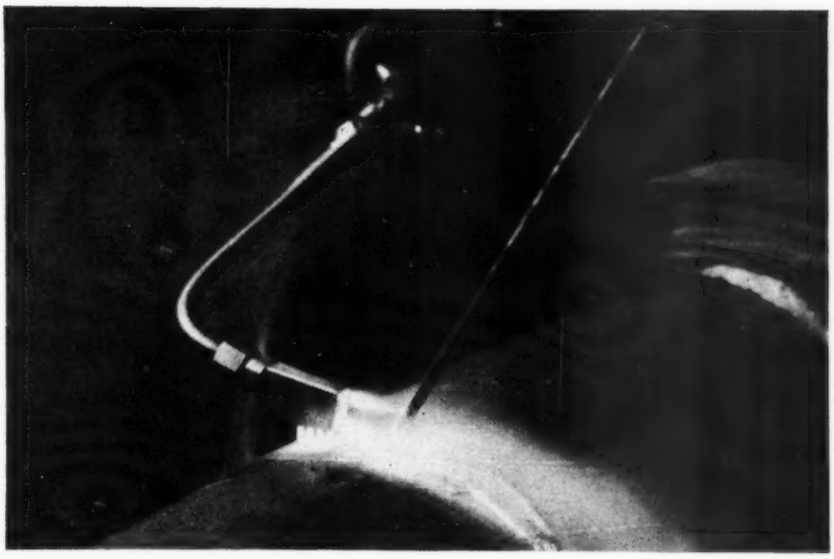
The 4-flame tip for position welding provides two flames for preheating the vee, one for preheating the rod, and one for actual welding

As in all Lindewelding, the flames should be adjusted with enough excess acetylene to give a feather about 1½ times the length of the inner cone. If this adjustment is made using the main welding flame as a guide, the other flames will be correct.

To direct the flame correctly, the blowpipe should be held with the tip parallel to the line of weld and with the welding flame pointing to the base of the vee. Then, the welding flame being maintained in this position the inner cone being barely out of contact with the metal, the blow-pipe should be rotated in the plane of the weld until the inner cones of the vee preheat flames are just above the metal. This automatically brings the rod preheat flame into correct position.

In welding, the rod and blowpipe movement is practically all back-and-forth or accordion motion along the

*The Linde Air Products Company.



The 6-flame tip for making rolling welds is similar in design to the 4-flame tip except that it has two additional flames for preheating the vee

line of weld, there being little or no motion transverse to the weld. Although actual melting of the rod is completed by the main welding flame, the auxiliary flame normally preheats the rod sufficiently to develop a visible red. The rate at which the rod is melted can be controlled by varying this preheating action through movement of either the rod or the blowpipe.

After the weld is begun, both hands should move in the accordion motion mentioned—one moving the blowpipe so as to prepare the vee and melt the rod alternately, and the other moving the rod in the puddle so as to direct the flow of molten metal. As less of the welding flame heat is required to melt the rod, more can be used to prepare the vee, thus increasing the welding speed.

The technique is essentially the same for various positions around the pipe except that the rate at which the rod is melted is changed as necessary. The procedure is to start at the top of the joint and proceed continuously to the lowest point, then start again at the top and make the other half of the weld similarly.

Welding Speeds—Four-Flame Tip

The figures for welding speeds and material consumption shown in Table 1 are typical of what may be expected on a well-organized pipe-line job using the all-bell-hole method of construction and the 4-flame tips.

As a basis for comparison with older techniques, data selected from field records show that 8-in. diameter pipe of ⅜-in. wall thickness is welded in approximately eight minutes using a 4-flame tip. Joints in 16-in. diameter pipe having a wall thickness of 5/16 in. required only about 12 minutes to complete.

The greater welding speeds now possible make the construction of overland pipe lines on scheduled time more than ever dependent upon efficient organization. The work of the various gangs must be coördinated so that the entire organization progresses efficiently.

Six-Flame Tip for Rolling Welds

The 6-flame tip is similar in design to the 4-flame tip except that it has two additional vee preheat flames. Four flames of this tip preheat the walls of the pipe, a fifth flame preheats the rod, and a sixth flame does the actual welding. This tip is designed for pipe diameters exceeding 6 in., and is available in two sizes—the first for pipe wall thicknesses from ¼ in. to 9/32 in., and the second for thicknesses from 5/16 in. to ⅜ inch.

Welding Technique—Six-Flame Tip

The technique described for the 4-flame tip also applies in its essentials to the 6-flame tip, except for modifications necessitated by the peculiarities of each type of joint. As all welding on a rotated pipe joint is performed in the same position, manipulation need not be adapted to changing conditions. In addition, the speed at which a rotated pipe joint can be welded, particularly on smaller diameters, is particularly dependent on the time required for the puddle to solidify, as solidification must occur before the puddle has passed beyond a horizontal position.

Welding Speeds—Six-Flame Tip

Because of the more effective application of heat, the 6-flame tip increases the speed on rolling welds over that for 3-flame welding by 35 to 70 percent, depending on the size of the pipe. As compared with single-flame Lindewelding, the speed of welding using the 6-flame tip is more than doubled. For example, results from the field show that the 6-flame tip averages somewhat less than five minutes per weld on 8-in. pipe having ¼-in. wall thickness, and approximately eight minutes per joint on 16-in. diameter pipe having a wall thickness of ¼ inch.

Table 2 lists the material consumption and speeds for various sizes of pipe using the 6-flame tip on rotating welds.

Welding Rod

A new low-alloy, high-strength steel welding rod has been specially developed for insuring uniformly high-quality welds in high-strength pipe welded by the multi-flame process. This rod is particularly suitable for use with the 4- and 6-flame tips. When applying the rod, the weld metal sets-up more rapidly, making it easier to control the puddle. This makes greater welding speed possible and also effects a reduction in gas consumption per weld.

Angle of Bevel

In general, an included angle of bevel of 60 deg. is recommended for all pipe wall thicknesses; however, where accurate spacing and line-up are assured, a 50-deg. bevel can be used, resulting in an increase in speed and a saving of 5 to 10 percent in the consumption of rod and gases. On a number of jobs in the field, excellent results have been obtained by using a 50-deg. angle for greater pipe wall thicknesses, such as 5/16 in. and ⅜ inch.

TABLE 1
Data for Making Position Welds Using the Four-Flame Tip

Pipe Diameter, In.	Wall Thickness, In.	Included Angle, Deg.	Rod Per Weld, Lb.	Oxygen Per Weld, Cu. Ft.	Time Per Weld Min.
6	0.250	60	0.38	8	4
8	0.250	60	0.45	11½	6
8	0.375	50	0.87	16	8
12	0.250	60	0.80	17	9
12	0.312	50	0.90	19	10
16	0.250	60	1.00	21	11
20	0.250	60	1.25	26	13

NOTE: Acetylene consumption is about 3 percent more than oxygen.

Small-Diameter Pipe

For pipe diameters of less than 6 in. and for wall thicknesses of less than ¼ in., the 4-flame tip should be used for rolling welds, as well as for position welds. The 6-flame tip is not recommended for rolling welds on pipe less than 6 in. in diameter because the rear preheating flames are of little value on pipe of this size.

Table 3 lists the speeds for both rolling and position welds on pipe of 2-in. to 4-in. diameter, using the 4-flame tip.

TABLE 3
Welding Speed on Small-Diameter Pipe Using the Four-Flame Tip

Pipe Diameter, In.	Wall Thickness, In.	Time Per Rolling Weld, Min.	Time Per Position Weld, Min.
2	0.185	1	1¼
2½	0.250	1¾	2
3	0.250	2	2¼
4	0.250	2½	3

Results On High-Pressure Gas Line

A southwestern natural gas company operating hundreds of miles of gas lines recently installed a high-pressure, 16-in. line, using the new 4-flame tips and high-strength welding rod. The results obtained on this line are interesting as an indication of the greater speeds possible using the new rod and tips.

The line is 20 miles in length and was completed in 27 working days. The all-bell-hole method was used on the first half of the line and a new procedure, known as the "one-third roll" method, was used on the other half of the line.

The pipe used on this line was 16 in. in diameter and ¼ in. thick. Operators easily averaged 33 welds per 9-hr. day, individual daily production being as high as 45 welds in nine hours. An average of 21 cu. ft. of oxygen, 21 cu. ft. of acetylene, and one lb. of high-strength steel rod was used for each weld.

Since its completion this line has been in service carrying gas at pressures exceeding 500 lb. per sq. inch. It has already gone through the coldest part of the year carrying peak loads without developing any trouble.

TABLE 2
Data for Making Rolling Welds Using the Six-Flame Tip

Pipe Diameter, In.	Wall Thickness, In.	Included Angle, Deg.	Rod Per Weld, Lb.	Oxygen Per Weld, Cu. Ft.	Time Per Weld, Min.
6	0.250	60	0.34	5½	3½
6	0.312	60	0.50	6½	3¾
8	0.250	60	0.44	7	4
8	0.375	60	0.80	12¼	6
10	0.250	60	0.52	8	5¼
10	0.375	60	0.98	16½	8
12	0.250	60	0.65	9½	5½
12	0.375	60	1.08	20½	10
16	0.250	60	0.84	13	7½
16	0.375	60	1.50	24½	12¼

NOTE: Acetylene consumption is about 3 percent more than oxygen.

One-Third Roll Method

As the one-third roll method has now been adopted by this natural gas company as its standard method of pipe-line construction, and has been used successfully on additional 6-, 8-, and 12-in. lines, it might be of interest to describe its variations from the all-bell-hole procedure.

Briefly, the pipe joints are lined-up and tack-welded on skids over the ditch in strings from 280 to 2000 ft. in length. A crew of operators first weld the top two-thirds of each joint. The weld is started at the 12 o'clock position and carried to the 4 o'clock position on one side, then from the 12 o'clock to the 8 o'clock position on the opposite side. As soon as the string is finished, this first gang of operators moves up to the next string, keeping as close to the line-up gang as possible.

When the top two-thirds of a string has been welded, the entire string is rolled one-third of a revolution. This brings the bottom unwelded third of the joint to a position convenient for welding. The second gang of operators, half the number of the first gang, then weld the remaining one-third of each joint in the string. This leaves one overhead weld to make on each string where it is tied into the main line.

Field Data on Six-Flame Tips

Reports from the field on the 6-flame Lindeweld tips indicate considerably greater speeds than those formerly obtained with the 3-flame tips for rotating welding.

On one 6-in. pipe line having $\frac{5}{16}$-in. wall thickness and a 50-deg. angle of bevel, rolling welds were completed in three and one-half to four minutes using the 6-flame tips. On an 8-in. line having $\frac{5}{16}$-in. wall thickness, the overall time per joint averaged four to five minutes. On still another line, operators easily averaged 40 rolling welds per 8-hr. day.

The new 6-flame tips have also proved particularly valuable for double-lengthing pipe. On one job that consisted of double-lengthing 12 miles of 10-in. diameter, $\frac{9}{32}$-in. wall pipe, use of 6-flame tips resulted in a saving of 20 percent over methods formerly used. On another job, welding time averaged eight minutes per joint for double-lengthing 16-in. pipe, an estimated increase of eight to ten welds per man per day over the number obtained using 3-flame tips.

Welding pipe by the "one-third roll" method

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Recent Progress in the Chemical and Physical Refining of Petroleum Products

By B. KWAL

PART 2

Refining of Gasoline

GASOLINE produced by refining crude oil can be divided into two sorts, straight-run gasoline and cracked gasoline. The former contains only compounds contained in the original crude oil whereas the latter contains different compounds, the composition of which depends upon operating conditions. Of course, the presence or absence of sulphur, oxygen, and nitrogen compounds depends only upon the kind of crude oil. Crudes containing sulphur yield not only straight-run gasolines containing sulphur but also cracked gasoline containing the sulphur compounds. It is true that these sulphur compounds differ in their composition, but it has been stated that all sulphur compounds reduce the value of any sort of gasoline.

Sulphur and its compounds when present in gasoline generally contribute to corrosion of the motor and its parts. If corrosion occurs at all, the extent or degree to which it occurs depends upon the type and quantity of sulphur compounds present as well as upon the type and quantity of sulditions of motor operation. Thiophenes, hydrothiophenes, sulfonic acids, alkyl sulphides, and mercaptans may be present in the crude and in the gasoline. Of course, all these compounds should be removed from the gasoline.

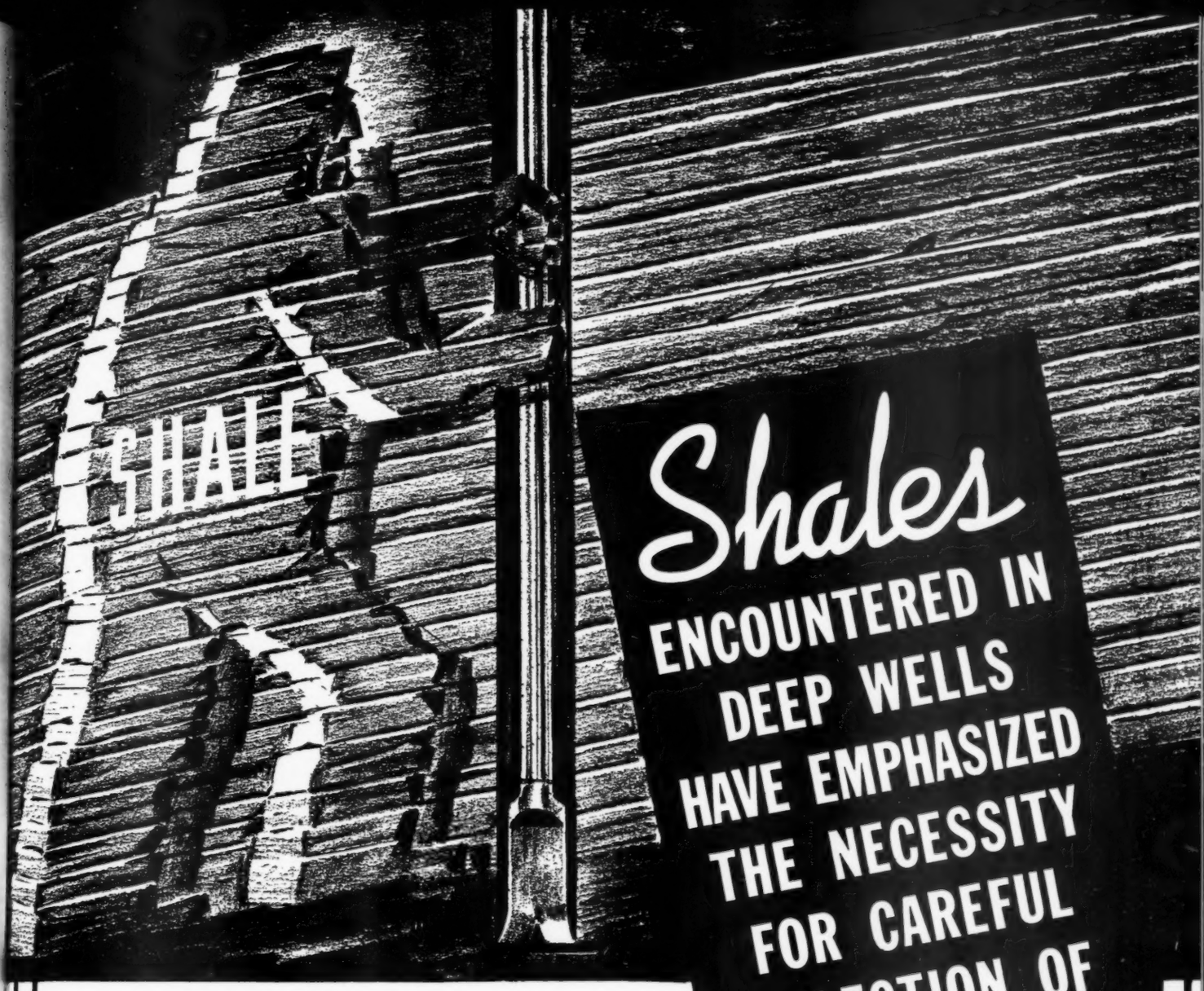
The cracked gasoline contains in addition certain hydrocarbons that impair its quality. The chemical composition of the cracked gasoline depends not only upon the type of crude, but also upon the conditions of treatment, that is, the temperature, time, and pressure. During the cracking process two sorts of olefins are formed, the mono-olefins and the di-olefins. The former possesses anti-detonating qualities but the latter has a deleterious effect on the quality of the gasoline. The ratio of the yield of these olefins depends only on the operating conditions. This indicates that the gasoline obtained by liquid-phase cracking differs from that formed during vapor-phase cracking. A large percentage of modern motor fuel is produced by cracking heavier petroleum oils at relatively high temperature and pressure. During this decomposition process both saturated and unsaturated hydrocarbons are formed. The saturated hydrocarbons are similar to those obtained from the crude oil by the so-called "straight" distillation. The mono-olefin compounds formed in this process are very desirable in the motor fuel because of their anti-detonating character. These olefins are stable and can be stored and marketed. The di-olefins, however, must be removed in the refining process, as they cause formation of gummy and resinous substances, undesirable in the motor fuel.

Olefins differ from the saturated hydrocarbons by the presence of a double bond between some one pair of adjacent carbon atoms. During the cracking process di-olefins and tri-olefins are also formed, these containing two or three double bonds. The di-olefins as a class are chemically more active than olefins, therefore they impair the quality of the gasoline. Of course, the location of the double bonds influences the stability of the di-olefins. If the two double bonds are adjacent, such di-olefins will show a very great activity, but if the double bonds are more distant the stability may approach that of the ordinary olefins. In other words, the greater the distance between the two double bonds of a di-olefin the more stable is this compound. Cyclic di-olefins containing adjacent double bonds seem to be less stable than the aliphatic di-olefins. It is very important to note here that the straight-run gasoline contains only small amounts of unsaturated hydrocarbons, of mono-olefinic character, whereas the cracked gasoline contains a preponderance of unsaturated hydrocarbons.

Let us now discuss the conditions under which mono-olefins and di-olefins are formed. The desirable mono-olefins of high anti-detonating character are formed in the liquid phase, that is, under comparatively high pressure and high temperature. Di-olefins are formed in the vapor phase, that is, when vaporized hydrocarbons are submitted to the cracking process at a high temperature and normal pressure. The reactions that lead to the formation of mono- and di-olefins are not yet explained but practically it is stated that the higher the temperature and the lower the pressure the nearer the double bonds will be, that is, the less stable the di-olefins will be. Therefore, operating conditions must be found that will produce the minimum of di-olefins. Furthermore, to remove these undesirable hydrocarbons, the gasoline obtained from the cracking process must be submitted to a chemical refining, a physical refining, or to a hydrogenating refining process.

The gasoline must be free from sulphur compounds and di-olefins. All undesirable compounds can be removed by the above-mentioned refining method except certain odoriferous sulphur compounds, known as mecaptans, or thioalcohols. In addition to the odor the mercaptans possess other undesirable properties. If elementary sulphur is also present in the gasoline, even in traces, the presence of the two makes the gasoline corrosive to metals, and such mixtures are conducive to discoloration of the gasoline. Therefore, these mercaptans must be converted into innocuous compounds, which remain dissolved in the gasoline.

The best known process of treating gasolines containing mercaptans is the so-called "doctor treatment," which consists of treating such gasolines with a small quantity of sulphur and an alkaline solution of sodium plumbite in water. The alkaline solution of sodium



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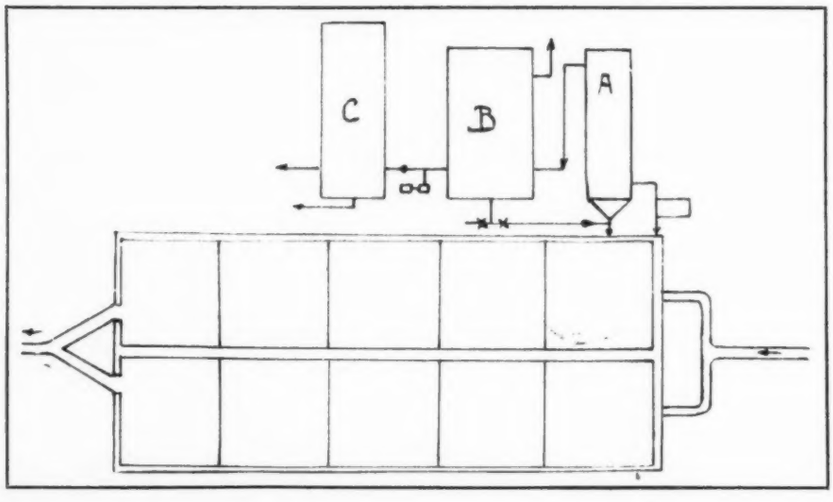
plumbite effects a chemical reaction between the mercaptans and the elementary sulphur, as a result of which the mercaptans are converted into dialkyl disulphides, and doubtless into some trisulphide, and the sulphur mainly into sulphides, polysulphides, thiosulphides, etc. This method, the so-called "sweetening process," is regarded as the best; however, the operating process possesses some disadvantages. After a batch of gasoline has been sweetened and the doctor solution drawn off, varying percentages of lead sulphide and doctor solution remain in the agitator, suspended in the gasoline or clinging to the walls or the cone. During the water wash or light caustic wash that follows, most of this material is drawn into the sewer and is lost. Berger has studied the economies in doctor treating, and believes that most of the losses in a typical system are caused by carry-over and evaporation. He describes a plant layout in which the doctor solution is always supplied fresh, and is never recirculated, and claims for it the advantage of reduced emulsification, reduced steam consumption, and steady operating conditions. Berger has studied several systems for the recovery of lead sulphide and gasoline carry-over. Probably the most efficient consists of a system of traps and settling tanks that serve the dual purpose of recovering the lead sulphide and improving the condition of the waste water released from the plant. It is always better to prevent carry-over rather than to make provision for recovering the lead and gasoline.

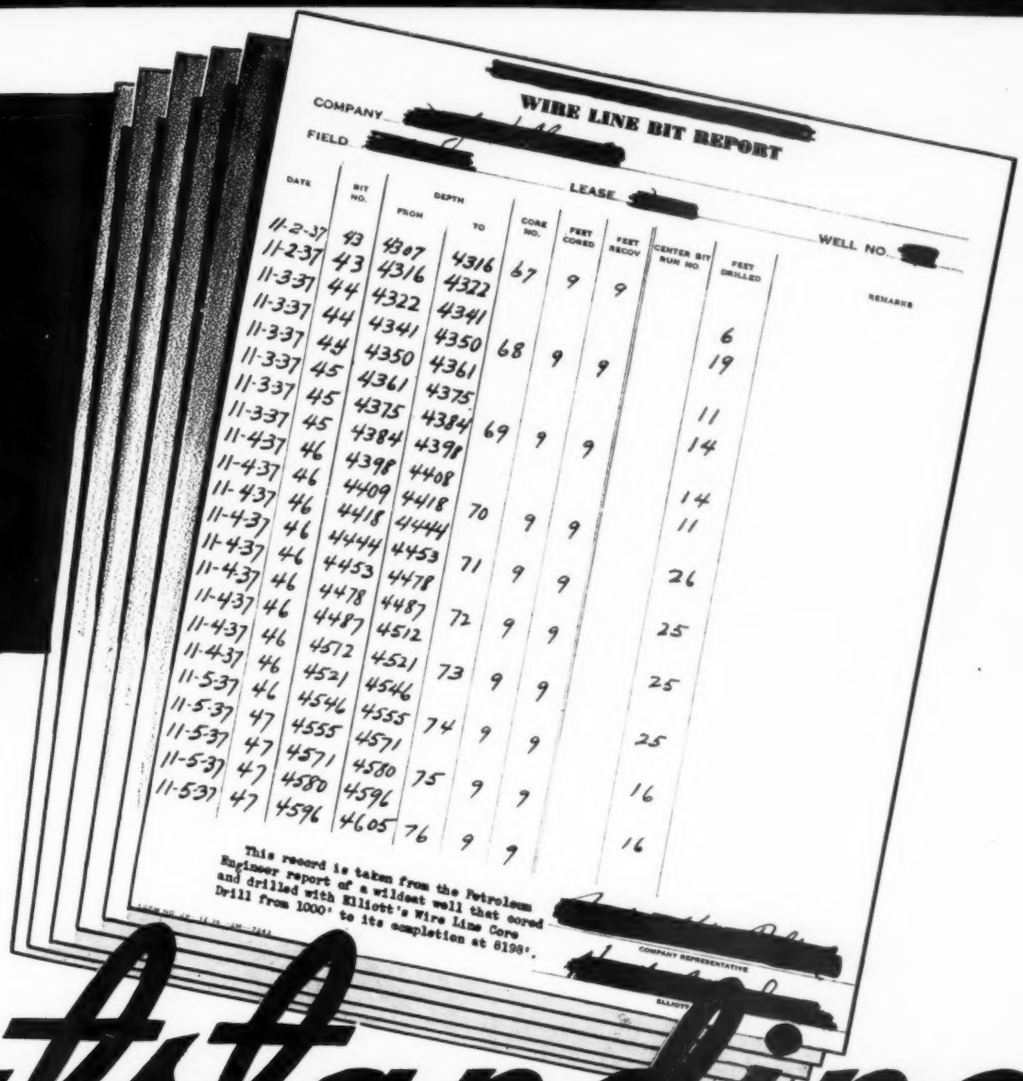
Black strap ordinarily exists in two forms, one of which is much heavier than the other. Suspended in slowly moving water, part of the black strap will fall to the bottom of the container and part will float. It is simply a matter of particle size and degree of emulsification with gasoline and air. To be effective, any trap for the purpose of removing and reclaiming black strap must include provision for collecting both the lead sulphide emulsion floating on the water and that which sinks. Semicircular troughs set perpendicular to the flow of water and dipping just underneath the surface will collect the gasoline and the light sulphide, and "mudhog" pumps can remove the heavier sulphide from the bottom of the trap when the trap is drained. Berger proposes that the traps should be built in parallel pairs so that the flow can be switched from one to the other to permit cleaning. According to Berger, the light black strap and the oil can be pumped continuously from the troughs to a separating tank *A* (Fig. 1). Water picked up with the gasoline and emulsion can be drawn off steadily and returned to the trap. The accumulated oil and lead sulphide can pass conveniently by gravity to the tank *B* intermittently. In the tank *B*, gasoline rises to the top of the emulsion and can be pumped to storage. From the bottom of tank *B* the stable black strap is pumped to tank *C* where it can be steamed to remove the gasoline or fed into a centrifuge for the same purpose. The recovered lead sulphide itself is then added in increments to doctor solution being regenerated. Black strap, the mixture of gasoline, lead sulphide, and caustic, contains about 12 percent lead sulphide, 42 percent spent doctor solution, and 46 percent gasoline. This mixture must be submitted to a recovery operation, which consists of pumping the mixture into a recovery tank where it is heated with steam and blown with air. It is evident that this operation causes gasoline loss by evaporation into the atmosphere. Berger estimates these losses to about 80 gal. per 1000 barrels. Besides, this operation has other disadvantages. If this gasoline is not entirely dissipated, the emulsion remains and the lead does not all dissolve. Furthermore, heavy, off-color gasoline ends remain in the recovered doctor solution and will discolor the fresh gasoline being treated. The remedy that Berger proposes is separation by centrifuge followed by regeneration of doctor solution in the usual way.

Fig. 1



Albright discusses the reduction of treating cost by alteration of plant design. (*Refiner*, 1936, 124 and 318.) First straight-run plus cracked gasoline is stabilized, then doctor-treated in a continuous plant consisting of two horizontal and one vertical vessels in series for treating and separating, and then the sweetened gasoline is inhibited, the over-all treating cost being five cents per barrel. According to Albright, the Sunray Oil Company reduced its soda plus doctor treating cost from six cents to two cents per bbl. by using alloy cast iron outside mixing nozzles, instead of perforated spiders, which were fixed in the soda and doctor washing columns, and by increasing the gravity of the doctor solution from 16 to 30 deg. Bé. to obtain efficient settling. The Wilcox Oil and Gas Company originally doctor treated in special towers, circulating the gasoline and doctor solution by separate pumps. Now one pump for gasoline is used per tower, the requisite circulation and mixing being obtained by using a system of jets and mixers placed near the base of the tower.

Bottomley stated that natural gasolines free of hydrogen sulphide, all straight-run distillates relatively free from olefins and aromatics, and some refinery recovery gasolines can be sweetened satisfactorily by hypochlorite. This reagent can be applied by batch or continuous operation in the normal type of plant. Bottomley proves that soda ash is cheaper than caustic soda, and can be used to make up the reagent. Thirteen hundred pounds of 58 percent soda ash is dissolved in 1000 gal. of cold water and into this solution is passed 350 gal. of chlorine. This concentrated hypochlorite is then diluted to 4000 gal. and agitated. Hypochlorous acid is formed as an intermediate product but in the presence of sodium carbonate reacts to give the hypochloride, salt, and carbon dioxide. Calcium hypochloride is also cheap and can be used satisfactorily, but tends to form emulsions during the treating and forms insoluble lime sludge. Bleaching powder as slurry or in solution is the third alternative of Bottomley. Schulze



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and Chaney (U. S. P. 2,028,998) propose a modified method of sweetening in which the hypochlorite-treated oil is mixed with a solution of caustic soda and potassium cyanide to reduce any alkyl sulphur chlorides present to disulphides.

Schulze and Buel (*Oil and Gas Journal*, Oct. 17, 1935) propose sweetening with cupric chloride both in brine solution and in a solid state. This method has several advantages. As no caustic solutions are used, natural gum inhibitors are retained. As no emulsions are formed, gasoline loss is reduced to a minimum.

Other desulphurizing methods have been patented by many investigators. An aqueous lime suspension under pressure (U. S. P. 2,030,245) was used by Crosby and Carney. Wattson proposes (U. S. P. 2,064,999) heat treatment with lime, and Retailleau and Wyman (Canada P. 355,082) propose the passage of gasoline vapors over iron oxide. Finally Malishew (J. Inst. Petr. Techn., 1936, 341) gives the results of his studies on the desulphuration of hydrocarbons by carbon monoxide using molybdenum sulphide as catalyst. He treated an oil four hours under an initial pressure of 1000 lb. at 300 deg. centigrade. In this operation he reduced the sulphur compounds of a hydrocarbon mixture containing thiophene from 0.85 percent to 0.05 percent.

Let us now discuss the possible method of operation recently suggested for the removal of unsaturated hydrocarbons that impair the quality of gasoline. These compounds can be removed either by chemical or physical refining. Sulphuric acid is the most widely known reagent used for this purpose, these unsaturated hydrocarbons being polymerized by its action. This polymerization may be defined as the union of two or more molecules of an unsaturated hydrocarbon to form a larger molecule, the latter being called the "polymer."

It is of great importance to control the process so that only the di-olefins are removed from the gasoline. Therefore proper conditions must be maintained in refining by means of concentrated sulphuric acid. Different valuable mono-olefins and other hydrocarbons can be removed from gasoline, causing loss of gasoline yield and decrease of the anti-detonating character of the gasoline. During the refining, esters, alcohols, polymers, and oxidation products can be formed. The extent to which any reaction takes place depends on the type of the gasoline, concentration and amount of sulphuric acid, and temperature. Refining the gasoline at high temperature causes the mono-olefins to react, resulting in reduced yield. At lower temperatures only di-olefins react with suphuric acid, because, as mentioned, the di-olefins are more active than mono-olefins. In other words, the di-olefins are more easily polymerized than mono-olefins. Polymerization is a function of temperature, and decreases with decreasing temperature.

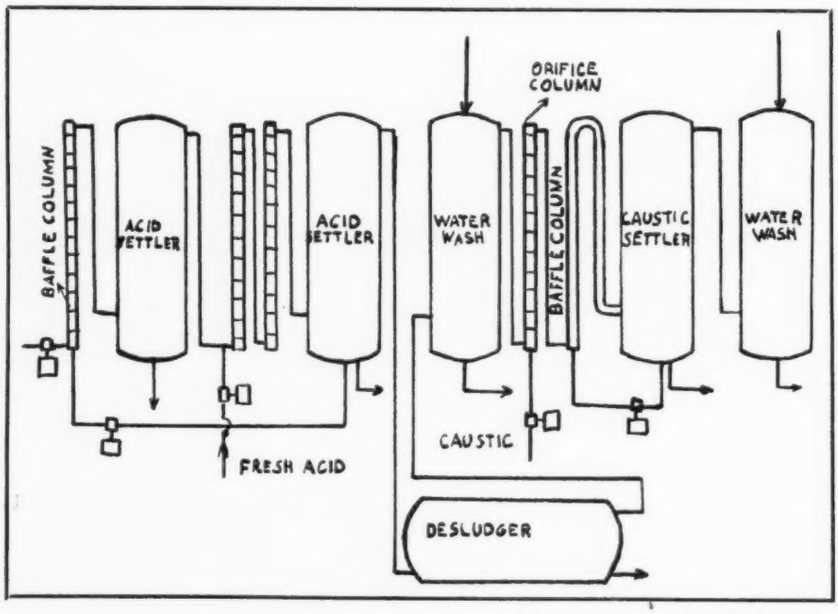
Of course, polymerization is also a function of acid concentration and quantity. The acid sludge-acid ratio increases as a straight-line function not only with the temperature but also with the strength of the acid. According to Morell and Egloff, the ratio decreases somewhat with increasing amounts of acid of the same strength between 5 deg. and 100 deg. fahrenheit. Increase in acid strength increases solution losses and polymerization reactions. The former is reduced by lowering the temperature, the reduction being substantially less than the decrease in polymerization, although very marked. The sulphur compounds also can be removed by this acid from the gasoline. The degree of desulphurization increases with increase of acid strength, but depends also upon the nature of the sulphur compounds and the type of distillate. Pre-treatment with soda has a beneficial effect on desulphurization.

Walton (*Refiner*, 1936, 94 and 160) discusses the acid treatment, and divides it into contacting, sludge removal, neutralization, and settling. According to this investigator, sulphuric acid of 59 deg. Bé. is strong enough for continuous treatment of most cracked distillates, and the recovery of this acid from the sludge is not worthwhile unless daily treating capacity is 35,000 bbl. or more. Provided the treating temperature is held below a certain limit, characteristic for each stock, and provided the mixing is efficient, the longer the time of contact the better will be the quality of the treated stock and the smaller will be the quantity of acid required. If the sludge is permitted to accumulate and the temperature is allowed to rise then undesirable sulphonation reactions will occur.

According to Walton, minimum contact time may vary from ten seconds to one minute. The horizontal settler is more efficient than the vertical settler in that the last particles to be settled are smaller. Baffles should be used to insure maximum travel of oil. Sager (J. Inst. Petr. Techn., 1936, 609) has also studied the chemical refining of cracked gasoline with sulphuric acid, and states that treatment with a given amount of acid of given concentration results in a definite sulphur content of the finished gasoline if the reaction is carried to equilibrium conditions, which may be reached in less than 60 seconds.

The conventional method of treating cracked distillates in the early days was by use of the batch agitator. The contact between the starting material

Fig. 2



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and the sulphuric acid was obtained either by circulating the liquids with a pump or by blowing with air, or both. This operation, however, had some defects. The air caused large evaporation losses, and the process did not provide efficient contact between the acid and the gasoline.

The modern continuous treating system has many advantages over the discontinuous batch operation. First of all, chemicals and time are saved, then the evaporation losses are considerably reduced by the use of a closed system under pressure and by the elimination of air-blowing. The continuous treating system produces an efficient contact between the gasoline and the reagent and satisfactory separation of the refined gasoline from the reaction products. Of course, the type of mixer plays the most important part. The orifice plate mixer can be regarded as the best. The area of the orifice should be divided into small holes rather than large ones. The energy of the high-velocity jets is dissipated on the downstream side in eddies and turbulent motion, which give efficient contact. Mechanical mixers can be used, and they also produce efficient contact. The treatment of gasoline with sulphuric acid in a mechanical mixer and immediate separation of the sludge and acid has been successfully applied by several refineries. Baffle plate mixers are not efficient but in conjunction with an orifice column or mechanical mixer show good results. The reason for this lies in the fact that the baffles serve to prolong the time of contact between the gasoline and the sulphuric acid. If the acid sludge is recirculated and applied in large volumes, the baffle column can be used to advantage. The settler plays a very important part in the chemical refining of cracked distillates by means of concentrated sulphuric acid. It should have sufficient capacity to allow the bulk of the sulphuric acid to settle. If the capacity of the settler is small, an excessive amount of caustic will be consumed, or if a water wash is used, the corrosion will be more severe on the water-wash settlers and lines. Conversely, the settler should not be too large. If the settler is so large that excessive settling time is given, the quality of the treated distillate is impaired. It is very important to control the process so that the settling time is not prolonged, otherwise esterfication will take place, resulting in poor color. The flow sheet of a modern continuous treatment with concentrated sulphuric acid is shown in Fig. 2.

Howes and Whitaker (*Refiner*, 1936, 363) prove that low initial and low operating costs can be achieved by using a contact tower of small diameter and four towers of large diameter in series, all containing special packing. The gasoline is circulated by a low-head centrifugal pump at a velocity sufficient for efficient contact with the acid. The first two large towers are desludgers, the third tower is employed for neutralization, and the fourth tower is reserve.

Cracked distillates and gasolines can be treated by the modern zinc chloride method. Bart, Gerward, and Bajdakowa (Now. Neft., 1936, 10, 7), who prefer using it in the solid phase, recommend careful selection of proper carriers and of methods of precipitating the reagent thereon, as well as development of suitable methods of reconditioning the spent zinc chloride. According to the newest patents of Lachman (U. S. P. 2,035,607; 2,035,610) and Egloff (U. S. P. 2,060,291) cracked distillate or gasoline and an aqueous solution of zinc chloride are heated under pressure, then allowed to vaporize by releasing the pressure, or the gasoline is mixed with air and this mixture passed through a suspension of zinc oxide in an aqueous zinc chloride solution.

As mentioned, the unsaturated hydrocarbons that reduce the anti-detonating character of the cracked gasoline can be removed by physical refining, in which the di-olefins are polymerized and separated. This operation must be performed in the vapor phase. The cracked distillates leaving the cracking unit in the vapor phase are directed to a tower filled with an adsorbing material. During the contact of the vapors with the adsorbent the di-olefins are adsorbed and polymerized into higher molecular hydrocarbons, which, having a higher boiling point, are easily separated from the gasoline vapors.

The Gray process of refining cracked gasolines in the vapor phase with a silicate continues to increase in popularity, as is evident by the addition of Gray towers to cracking and combination units in many refineries. There are many patents pertaining to treatment of gasoline vapors with clays, among them being the Gray process, the Osterstrom process, and the Strattford clay treating process. Gray prefers to pass the vapors being treated through the adsorbent and the commercial development of the Gray process continued in this direction. Strattford (U. S. P. 1,768,342) found that the specific problem confronting him could best be solved by countercurrent treatment of cracked gasoline vapors with a slurry of fine clay in naphtha. Finally Osterstrom achieved certain advantages in overcoming still another type of problem by subjecting the cracked gasoline to treatment under high pressure, thereby maintaining it in liquid phase at polymerizing temperatures. All three processes are used commercially, but the latter two have until recently been limited in their application because the Gray process is simpler and more generally adaptable.

Brazhnikoff (Neft, 1936, 21) found that the clay from Zikeev, Russia, can be used satisfactorily in vapor-phase refining, and states the consumption amounts to 0.3 percent without regeneration of the gasoline treated. Glucman (Azerb. Neft. Khoz, 12, 60), however, believes that although the Russian clay gumbrin can be used in the vapor-phase method, a more nearly stable gasoline is obtained by treatment in the liquid phase.

Solvent extraction, which is used in the refining of heavier oils, now has been extended to gasoline for the manufacture of motor fuel having higher anti-detonating properties. This method is not yet properly developed but it would be of interest to mention some features. W. M. Strattford (U. S. P. 2,024,117) proposes the solvent extraction with furfural-water to remove ten percent extract consisting of gum-forming constituents, and Hassard (Can. P. 356, 562) proposes the extraction of the impurities with methanol containing picric acid.

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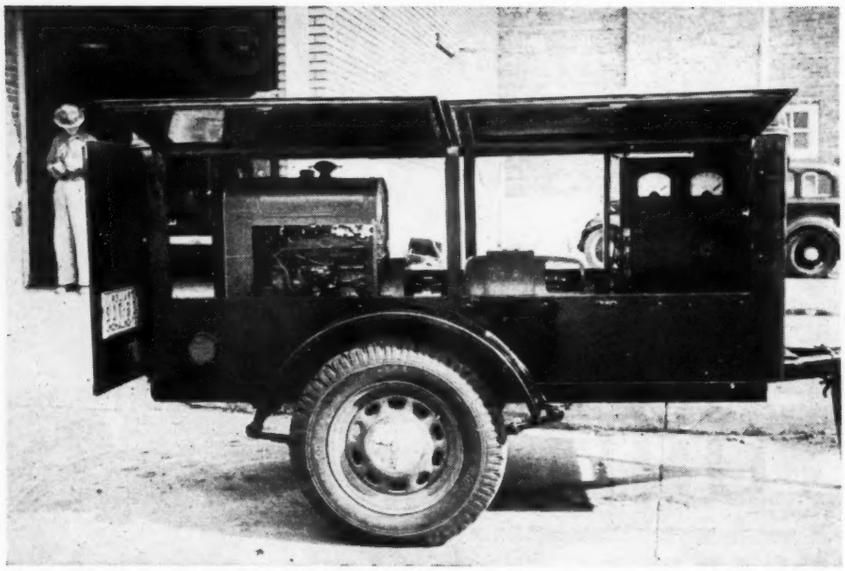


Portable set for making preliminary tests to determine proper location for cathodic protection unit

By
D. B. GOOD
Electrolysis Engineer,
The Texas-Empire Pipe Line Company

Careful analysis of conditions for each location and suitable tests after unit is placed in operation are essential factors in protecting pipe lines cathodically

Cathodic Protection of Pipe Lines For Mitigation of Corrosion and Electrolysis

CATHODIC protection is defined as that method whereby a suitable negative potential is imposed upon a substructure in such a way as to protect it from corrosion.

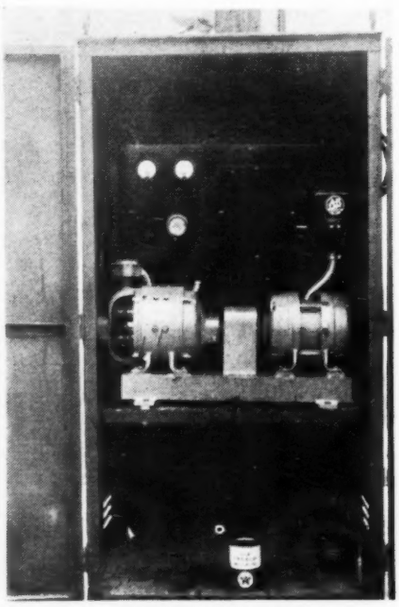
Brief History of Cathodic Protection

Strictly speaking, the earliest efforts at pipe protection were those in which underground systems such as cables, water mains, gas lines, and oil lines were bonded through other underground conductors or directly to the negative of substations supplying d-c. power for street cars or electrified railways, when the return circuit was not an insulated one. In these systems the stray power currents were harnessed wherever possible, because of the necessity of maintaining and operating the underground systems. The currents drained or returned by such systems are usually many times greater than those employed in the more generally recognized system of cathodic protection now in existence, but still in its infancy. Both are the same in that the pipe line, cable, gas line, and water main are made sufficiently negative to the soil in which they are buried that no currents can leave the structure to ground, but must return by line to the negative source of power. In proper installations the substructures are made sufficiently negative to the soil in which they are buried that the potentials existing to cause corrosion or electrolysis are counteracted and even exceeded, thus eliminating the cause of pitting and loss of metal.

It is generally recognized that corrosion is electro-chemical, the cells of corrosion being either minute in their paths or very long, in the case of long-line currents, when even miles of line are sometimes included in the circuit.

The earliest attempts at cathodic protection, aside from the bonding to substations, were conducted by R. J. Kuhn of New Orleans, whose efforts date back to 1928.

Cast-iron pipe was laid as early as 1817 and we know that in recent years thousands of miles of steel pipe and cast-iron mains have been laid, most of which have been covered with protective materials of varying quality, until at the present time many millions of dollars are spent annually to repair or replace pipe lines made useless by corrosion and electrolysis. Aside from the actual cost of repair or replacement there are losses of oil from oil lines, damages from oil losses, and loss of time for shut-downs when such are necessary.



A small motor-generator set for cathodic protection of a river crossing

Types of Corrosion

We have accepted, then, the electro-chemical theory of corrosion, involving galvanic electric currents as well as the chemical changes taking place in the iron or steel leaving the parent metal. There are several distinguishable types of corrosion.

In Type 1, of galvanic action, the current flows from the pipe through the soil and then back to the pipe. The points of discharge are anodic, and the points of entrance are cathodic. Type 2 is referred to as long-line currents, where the cell circuit may be hundreds or thousands of feet in length. The currents are measurable. Type 3 is referred to as electro-chemical, where the paths of the current are minute and the current cannot be measured. Electrolysis is yet another type where pipe

can suffer greatly from loss of currents. By reversing the process, causing current to enter the pipe at all points, the corrosion and electrolysis can be eliminated.

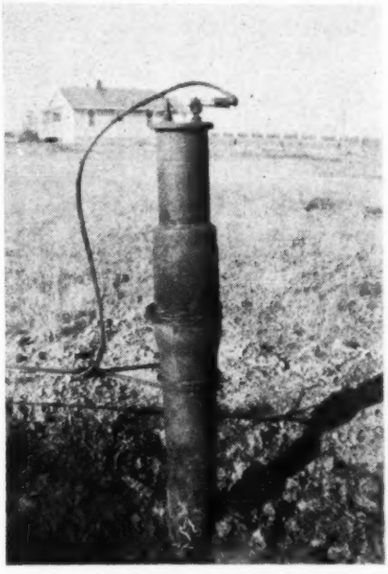
Circuit for Cathodic Protection

The circuit for cathodic protection of a pipe line or other metallic structure in the ground consists fundamentally of a source of d-c. power, the negative being connected through insulated wire to the pipe line or structure to be protected and the insulated positive leading to an auxiliary ground bed or anode, placed some several hundred feet from the pipe line. This distance is not critical provided a minimum of about 100 or 200 times the pipe diameter is used, and in most cases no special added effects will be obtained by increasing this distance, although special cases and terrain conditions may make longer distances from pipe line to ground bed desirable. Current is forced from the anode or ground bed, spreads in fan fashion through the earth and is picked up by the pipe line wherever abrasions or holidays are existent in the protective coating. We have assumed that the pipe line is "doped" or insulated to a greater or lesser degree. The current thus picked up follows the pipe line back to the point of negative connection and to the negative of the d-c. source of power, to complete the electrical circuit. In this process the potential of the pipe to ground has been changed, depending upon the degree of protection desired, upon the condition of the coating on the pipe, the size of the pipe, the kind of soil in which it lies, the original potentials of the pipe to ground, design of protective unit, with reference to proper ground bed location, and location of the unit itself. At points where the current enters through the holes or holidays to the pipe, protective films are formed, which inhibit further corrosion. By one analysis the heavy white material thus formed was reported as being composed of sodium bicarbonate and sodium carbonate in the ratio of about 2 to 1. The pick-up points or areas become alkaline with a pH greater than 9.6. Iron is insoluble in a caustic solution of this pH in the absence of oxygen. This film or chemical plating must be broken or destroyed before corrosion will resume its activity, and consequently the practicability of procuring protection of underground structures by means of intermittent cathodic protection is established.

Having drawn the picture of the simple electrical circuit required, we will briefly discuss the various parts of this circuit.

Rectifiers and Generating Equipment for Direct Current

First, the source of direct current: varied equipment is available for obtaining direct current from alternating current. Perhaps it should be pointed out here that electrolysis from alternating current is practically negligible as determined by tests made by the U. S. Bureau of Standards, for with alternating current the metal may be replaced at just about the same rate it is taken off. Alternating current is a problem not ordinarily considered, therefore, as far as pipe electrolysis is concerned.



An anode 60 ft. long made from street car axles

The alternating current may be changed to direct current by any of the rectifying equipment now available, such as bulb-type rectifiers, Rexselen rectifiers, copper-oxide rectifiers, and motor-generator sets. The last three are most commonly employed at present.

Copper-oxide rectifiers are used to a great extent as they have no moving parts, require only infrequent regular inspections, and have a good service life and efficiency. The Rexselen type is of the same character, but uses a different rectifying element. It is reported as being satisfactory in this application and to date has been used mainly on the West Coast. Both are adjustable for various outputs.

Motor-generator sets are very satisfactory and are easily adjusted for varying their output to suit the particular drainage changes desired at each location, as seasonal variations in the ground-bed resistance may demand. The motor-generator sets are particularly adaptable in pump stations or points where frequent inspections may be readily made.

Another source of direct current is the contact of a dissimilar metal with steel. Some applications of zinc plates have been made. In these applications the zinc plate is anodic to the steel and sets up the necessary voltage difference and also serves as the ground bed.

For very small currents other types of cells have been constructed. The application of such units is limited, however, as with zinc plates to small localized areas or "hot spots" or to special cases.

Gas engines also have been used by gas companies as motive source for driving d-c. generators.

The wind-driven generator already has proved itself of importance in the field of cathodic protection where power is not available, but where corrosion is active. The wind-driven generator was originally developed by The Texas Pipe Line Company through J. L. Culbertson, chief engineer. The first installation was made near Port Arthur, Texas. As the operation of the generators is intermittent, the effectiveness of the protection supplied to pipe lines is dependent upon the polarization effects that tend to maintain the pipe in a non-corrosive condition through the lull periods, provided the line has been sufficiently polarized by previous operation. Mechanically the wind-driven cathodic-protection generator unit is being improved from year to year and numerous installations are to be found in out-of-the-way

A vertical ground bed of nine 28-ft. grounds interconnected by a rail header

places along pipe lines, particularly in Texas.

Pipe Coating

Next consider another part of the circuit, the pipe itself. Naturally the better the insulation on the pipe, the less the difficulty in maintaining a potential difference between it and the soil, as the pipe would act as a condenser if it were perfectly insulated and a static charge could be maintained. The reasons why a coating job should be as nearly perfect as possible are as follows:

(1) Longer pipe life is obtained.

(2) It is possible to procure longer pipe-line operation before application of cathodic protection, and with cathodic protection.

(3) The energy required per mile is less with good coating.

(4) Distance between drainage points can be increased.

(5) Equipment investment is lowered.

Better pipe coating jobs are being obtained from year to year as more time, money, and attention are being given to this phase of pipe-line construction. One of the reasons why more nearly perfect coating jobs are being obtained is the use of the "holiday detector," an electrical means of locating pin holes or abrasions in the coating before pipe is lowered in the ditch. Places are located where only the primer is on the pipe, where pin holes or bubbles appear, where foreign substance is under the coating or in the primer coat, and where the pipe has been improperly cleaned. One test at the start of a doping job applied by contractors revealed, for a 6-in. pipe line, in a 100-ft. distance, some 100 "holidays" after the first coating, 30 after the second coating, and four after the third coating.

Feeders

The negative and positive feeders, of course, should be of sufficient size to carry the current involved without any great voltage drop. Usually 4-0 copper wire is used.

Grounds or Anode

The total circuit resistance consists of several parts such as contact resistance between the anode and soil, contact resistance between pipe and soil, and d-c. power circuit resistances, but the major individual part of the total is the anode resistance to ground, which may vary more or less with time, depending upon location, season, ground-bed design, rainfall, current densities at the anode, and general earth conditions. The ground bed is one of the most important parts of a cathodic protection installation. Junk pipe, cast-iron, or junk rails provide excellent anode material. Carbon rods are not often used as they have not proved as satisfactory as junk, cast iron, or steel. Grounds are treated with chemicals, usually salt, to lower their contact resistance. In the process of cathodic protection the anode is acutely attacked by the current discharging from it. A report on ground-bed design and installation constitutes a lengthy discussion in itself. Ground beds may be placed vertically or horizontally and in any desired position relative to the pipe line course without materially affecting the extent of pipe protected or efficiency of operation, so long as proper distance is maintained between the pipe and anode, and lowest available points of ground resistance are used.

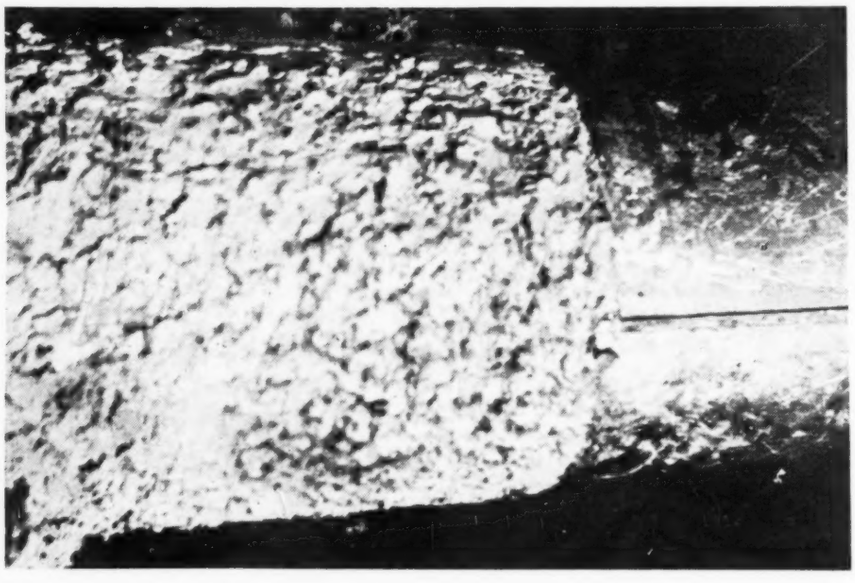
Voltage Required to Protect Substructure

There is a diversity of opinion as to the voltage by which the pipe must be made negative to soil to fully protect the pipe against corrosion. Some are of the opinion that maintaining the pipe 0.3 of a volt negative to soil is desirable or necessary, others, 0.2 volt, and some even as low as 0.1 volt. It is quite probable that different voltages may be required in various locations, condition of soil, and condition of surface of pipe being protected. It is believed, however, that if the pipe is maintained 0.3 volt or more negative to soil there can not be corrosion. The records of numerous lines where such voltage has been maintained are available to strengthen this statement; however, 0.2 volt may be sufficient on some lines. The decomposition of chemicals in contact with the pipe line is about 0.34 volt. Sets of corrosion coupons buried at different points along one cathodically-protected line have shown that corrosion occurred where the pipe was 0.25 volt negative to soil 24 percent of the time, 0.15 volt negative 43 percent of the time, 0.10 volt negative 19 percent of the time, and at about equilibrium potential 14 percent of the time, or, in other words, at a potential of 0.10 to 0.25 volt negative 86 percent of the time. The loss of metal noted could not be attributed to the 14 percent of time of no cathodic protection.

Power Requirements

Power requirements are dependent upon the size of line to be cathodically protected, length of line, whether in country or city, number of crossing substructures or parallel lines, amount of cross-bonding required, number of resistance bonds to other lines near-by, kind of soil in which the line lies, condition of the coating on the line, design and location of ground bed, efficiency of the rectifying unit, degree of protection desired or the amount that pipe is desired to be made negative to soil, number of tie-ins to main line and whether such tie-ins are electrically separated from the main line, location of unit with respect to the section being protected, soil resistivity, and the cost of power. The most important items are the unit resistance of the coating, cost of ground bed, and the unit cost of electric energy.

Cases are reported where units operated from 0.1 amp. to drainages of several hundreds of amp. when lines are bonded to sub-station negatives. Some units are operating at about 30 amp. at 20 volts to protect 5 to 15 miles of a 12-in. asphalt-coated line. Each case must be individually treated,



Coating distortion caused by heavy clay

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and costs of protection figured against cost of reconditioning or the maintenance costs.

Some figures at hand from operating units show for a 12-in. line coated with asphalt a cost of protection of $11.00 per mile per year in one area and $65.00 per mile per year in another. For 12-in. to 16-in. lines these costs, in some reported cases, vary from about $50.00 to $250.00 per mile per year. In any event it is a case of economics, which must be figured for each situation, but in numerous cases the cost of protecting lines cathodically is so much less than the cost of any extensive repairs or reconditioning that each year sees more applications of this proved method of stopping corrosion.

Methods of Determining Pipe Protection

(1) The most common instrument used for determining the potential to ground of substructures is the McCollum earth current meter or Rawson voltmeter, having a resistance of 1,000,000 ohms per volt, and using a non-polarizing copper sulphate electrode, which gives a practically unvarying potential in any electrolyte. Values of potential of pipe to ground, as often noted before cathodic protection is applied, may be 0.50 to 0.60 volt, when the pipe lies in the country and is free from stray power currents. The copper sulphate electrode is about 0.57 volt positive to ordinary pipe steel but this may vary slightly for different steels. For any reading below 0.57 the pipe is positive to soil by the difference between the reading and 0.57 and for readings greater than 0.57 volts the pipe is negative by the difference between 0.57 and the reading. For a 0.3 volt condition of pipe negative to ground the Rawson reading would be 0.87 volt.

After the application of cathodic protection, polarization effects are noticeable for a period of about two weeks.

(2) A second method of testing to determine whether or not the pipe is receiving full protection or to what degree, is by the placement of corrosion coupons, one attached to the pipe line and the other free in the near-by soil. Coupons are weighed before installation and after a period of time to determine if they have lost weight from corrosion. The unattached coupon gives an index to soil corrosion alone.

(3) Some companies measure or determine the flow of current, either to or from the coupon that is attached to the pipe, as a means of establishing whether the pipe is anodic or cathodic.

(4) Yet another method is known as the "cloth test," wherein a small area the size of a postage stamp is cleaned and a white rag, soaked in salt water solution, is placed over it, first having been touched to the adjacent soil before being placed on the pipe. A control nipple likewise is treated, and the bell hole covered for two to three days, then reopened, the rags removed and allowed to dry, and then washed in clear water. The cloth from the pipe line should appear white if no corrosion is taking place, whereas the rag from the nipple will be rust-stained. This test was conducted by McGary and used, after drainage was discontinued, after having been applied for 15 days. He reported no corrosion at the end of 30 days.

Conclusion

(1) A reasonably well coated line can be economically protected against corrosion by cathodic protection.

(2) Bare surfaces may be protected against corrosion but at higher cost, which may be warranted in some lines.

(3) There are no dangers attached to the use of cathodic protection but certain precautionary measures must be observed in the operation of cathodic units.

(4) Cathodic protection is simple in installation and operation, but requires careful analysis of conditions for each location and suitable tests after being placed in operation.

(5) Cathodic protection may stop corrosion at any stage and its effectiveness is not dependent upon the kind of pipe metal to be protected or the soil in which the pipe lies.

A 24-hr. chart of d.c. on a pipe line, showing fluctuations. The "V" on chart was caused by a heating load condition on a nearby electric system

(6) The application of cathodic protection in corrosion and electrolysis mitigation is receiving widespread acceptance. New data are being constantly developed, but the method and its uses are still in the early stages of development.

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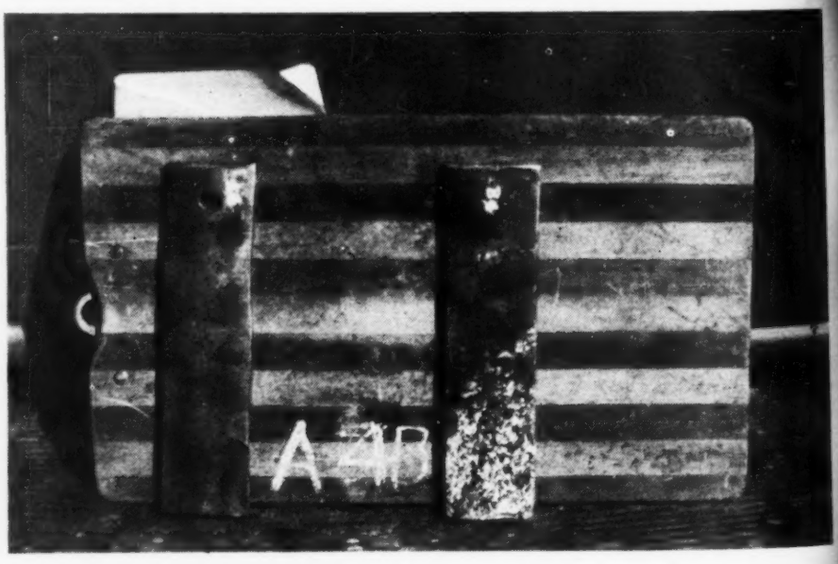

Coupon "A" was attached to pipe receiving cathodic protection. Coupon "B" was unattached and being free in the soil corroded

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The name "HUGHES" is known the world over where Rock Bit formations are encountered in drilling for oil. It stands for speed, safety, and results in making hole, under even the most difficult conditions.

Determination of Heat Waste Caused By Deposition of Soot

Efficiency of oil-field and refinery boilers is greatly reduced by a relatively small quantity of soot on tubes

By W. F. SCHAPHORST

THE chart shows the percent of fuel wasted where soot is permitted to accumulate in the flues of oil-field or refinery boilers. The dotted line drawn across the chart shows that when the inside diameter of the soot deposit "d" is 3 in., the fuel loss is 44 percent.

Run a straight line from D to d and the intersection with column C shows the fuel waste directly.

Assume D = 2 and d = 2. That is, there is no soot. The fuel waste is zero. Next try D = 3 and d = 3. The fuel waste is zero again. When the soot is thick the fuel waste is great.

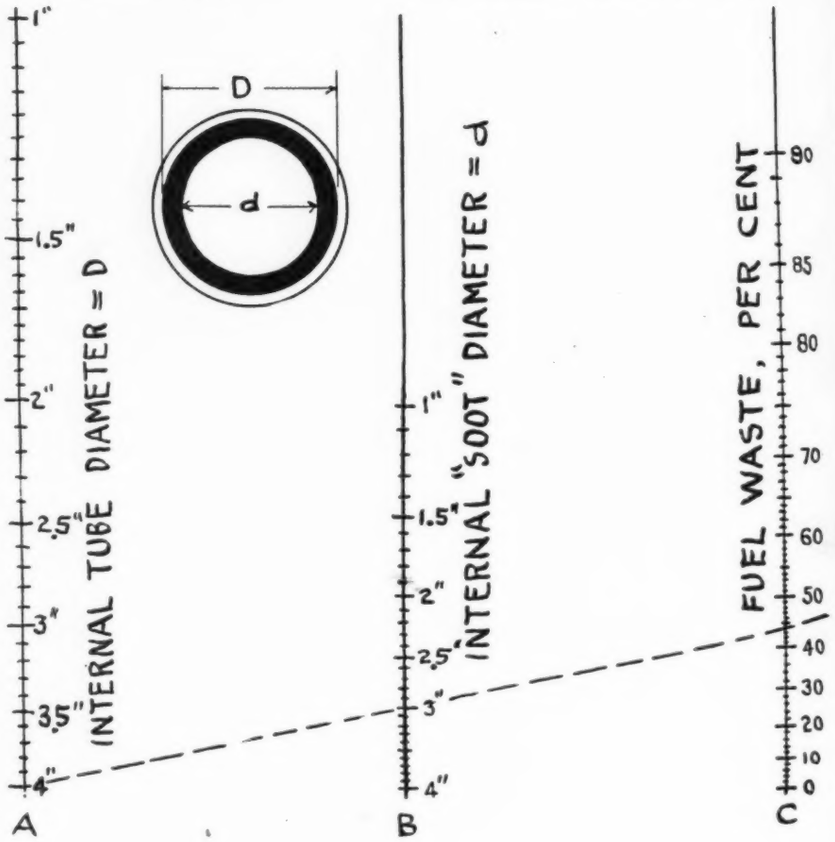
These simple examples in themselves prove the soot should always be kept off boilers; it is about the best "heat insulator" known. Asbestos is commonly regarded as a very good insulator and is generally so used, but soot is even better than asbestos. Kent in his Mechanical Engineer's Pocketbook states that soot has five times greater heat-stopping properties than has asbestos, so it would appear that soot would do very well for packing around our steam pipes to stop heat radiation and to prevent condensation. It is almost as good as loose wool and live goose feathers (according to Kent); those two substances are about the most effective insulators known.

Obviously, the principal reason that soot is so uneconomical is that it gets between the fire or hot gases and the boiler shell or flue. That is the very position in which there should be no insulating medium at all because that is where an insulator can do most harm. It has been shown in carefully-conducted tests that an insulator between water and metal is not so effective as between gas and metal. Hence, a given thickness of soot on the outside is far worse than an equal thickness of scale inside a boiler. Soot shuts off heat "at the very source". It doesn't give the heat a chance even to touch the metal of the boiler.

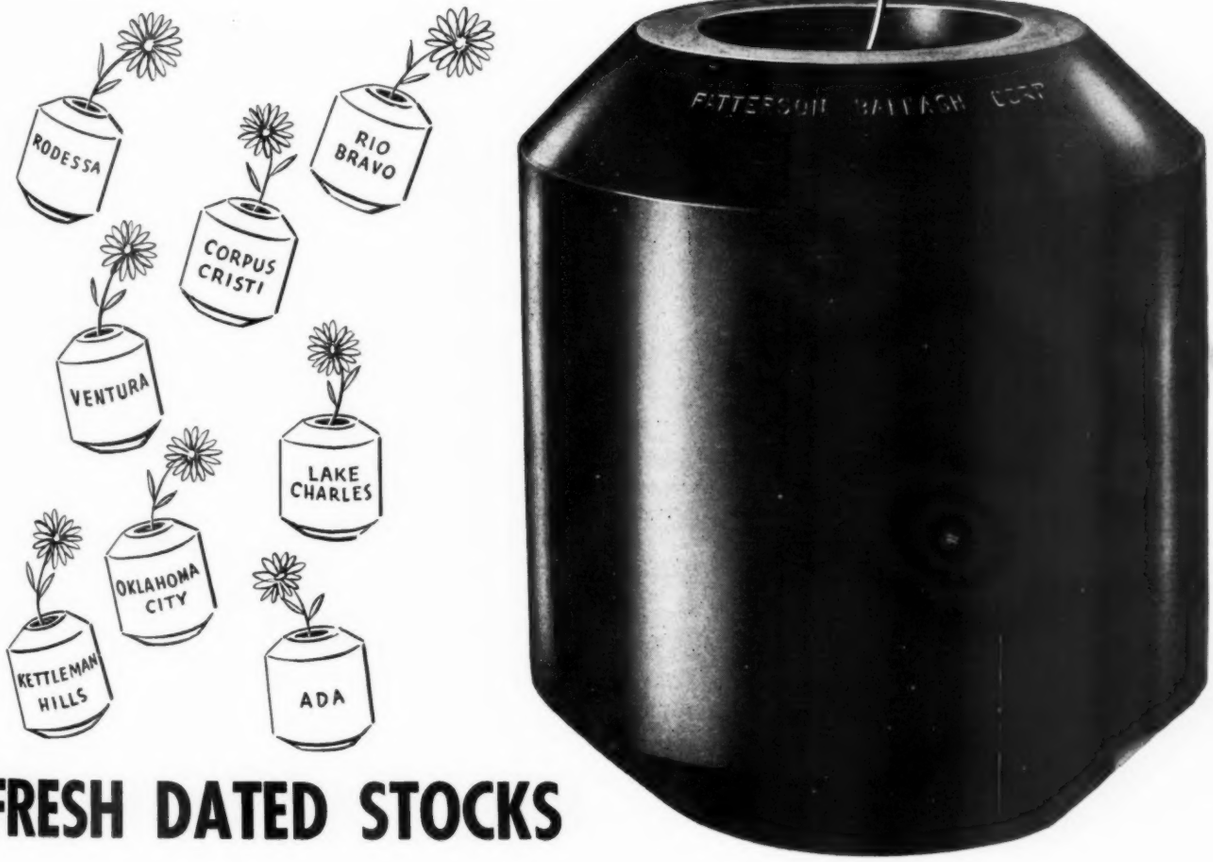
Therefore, soot is a creator of inefficiency, and at the same time a reducer of boiler capacity. By keeping soot off boiler and flue surfaces a boiler can be "forced" with better effect than when soot is permitted to accumulate. This can easily be proved by taking temperature readings of flue gases. Tests have proved time and again that when soot is kept blown-off, the average flue gas temperature is materially reduced. Boiler efficiency can be measured very simply and with considerable accuracy by merely taking the flue gas temperature.

Now that we have soot blowers of so many makes, a boiler owner should have no difficulty in procuring a type best fitted for his conditions. They are made for any make of boiler and are either hand-operated or mechanically operated.

After using this chart and determining approximately the present percentage of fuel waste in your boiler room, multiply that percentage by the yearly cost of your fuel. The product will be the yearly cost of the soot. For example, if the chart shows the loss to be 15 percent and if you spend $5000 per year for fuel, the yearly cost of soot is $5000 × 0.15 = $750.



FRESH AS A DAISY
IN EVERY DRILLING FIELD



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LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

Wife (at Pearly Gates): I have come to join my husband.

St. Peter: What was your husband's name?

"Joseph Smith."

"I'm afraid that will not be sufficient for us to identify him by. We have a lot of Joseph Smiths here. Is there any other means by which I can identify him?"

"Well, before he died he told me that if I ever kissed another man he would turn over in his grave."

"Oh! I know the chap. Up here we call him Whirling Joe!"

* * *

Have you heard of the absent-minded traveling man who wired home for reservations?

* * *

If men shopped as women do: "I wonder if you can get me a neat purple stamp with a dinky perforated hem, the tout ensemble delicately treated on the reverse side with mucilage. Something at about three cents, please."

* * *

A small Jewish youngster, shrewd as his race, was taken to see his new baby brother. "Mamma," he cried, "the kid ain't got no hair; it ain't even got no teeth. Mamma, somebody's gypped us. It's an old baby."

* * *

The college president was disciplining an unruly student.

President: I am told you have a barrel of beer in your room.

Stude: Doctor's orders, sir; he said if I drank a lot of beer I'd get my strength back.

Pres.: H'm—and did you?

Stude: Absolutely. When that barrel came in I could hardly move it and now I can roll it all around the room.

* * *

Young Coed: Oh, Dad, I've just discovered that the girl who sits next to me in Bio. has a hat exactly like mine.

Father: So I suppose you want me to buy a new one?

Coed: Well, Dad, that would be cheaper than changing schools.—*Slambang.*

* * *

The famous detective arrived on the scene.

"Heavens," he said, "this is more serious than I thought—the window is broken on both sides."

Proving It!

A league for the protection of henpecked husbands was formed in a small Kansas town, and at the first meeting a man named George was elected president. George had just taken the chair and banged the table for order when a tall, gaunt, stern-looking woman burst into the hall, rushed at George and seized him by the collar.

"You come home!" she shouted, shaking him. "What business have you in a place like this? *You're* not henpecked!"

* * *

The foreman on one of the WPA projects found that due to breakage and wear and tear he had run short of shovels, so he wired to Mr. Hopkins in Washington, requesting that more shovels be sent to him.

The next day he received a reply, which read: "Have no more shovels. Tell the men to lean on each other.—*Record.*

* * *

"Senator, you promised me a job."

"But there are no jobs open."

"Well, you said you'd give me one."

"Tell you what I'll do: I'll appoint a commission to investigate why there are no jobs, and you can work on that."

* * *

Rastus: What's de mattah, Mose? You ain't acting like yo'self.

Mose: Ah's got insomnia. Ah keeps wakin' up ev'y two or three days.

* * *

The scissors grinder says his business is fine for he never saw things so dull in his life.

* * *

John: What time have you?

Harry: (looking at watch): A quarter to.

John: Quarter to what?

Harry: Dunno. You see, times got so tough I had to lay off one of my hands.

* * *

The little child was sitting demurely on the couch, watching her mother smoking a cigarette. Her little nose was wrinkled and in her pale blue eyes there was an expression of childish disillusionment. Finally, unable to stand it any longer, she burst out in her quavering falsetto:

"Mother, when the deuce are you going to learn to inhale?"

As the day dawned, two guards, armed to the teeth, brought a beautiful and young white prisoner to the king of the cannibals.

"I think," said the king, "that I'll have my breakfast in bed this morning."

* * *

The minister stood before the happy couple and was about to pronounce them man and wife.

"Does anyone present," he asked, "have anything to say before this marriage is consummated?"

A moment's stillness ensued, only to be broken by an enthusiastic young man. "Do I understand that no one wishes to say anything?" he enquired.

"It would seem so," replied the minister.

"Then," continued the young man, as a light came into his eyes, "may I be permitted to make a few remarks about Southern California and its wonderful climate?"

* * *

Rock-a-bye baby, why do you fret;
Are you aware of the national debt?
Father has gone 'round the corner to vote
Millions in bonds for his snookums to tote.
Are you suspicious? Sleep while you can.
You can squirm later, dear, when you're a man.

* * *

Mrs. Newrich was fond of flowers and especially liked the salvia, but was not very reliable in getting the names right. She was giving directions to her gardener. "On this side of the walk," she said, "I want you to put out some salivas. Now what would you suggest for the other?"

"Well, madam," answered the gardener solemnly, "maybe it would be a good idea to put some spittoonias there."

* * *

Something else to wonder about: How the fool easily parted from his money ever got it in the first place?

* * *

Lady: I sent my little boy for two pounds of plums and you only sent a pound and a half. Something must be wrong with your scales.

Storekeeper: My scales are all right, madam. Have you weighed your little boy?—*The Yellow Strand.*

BAKER CEMENT RETAINER

THE MODERN SOLUTION TO CEMENTING PROBLEMS

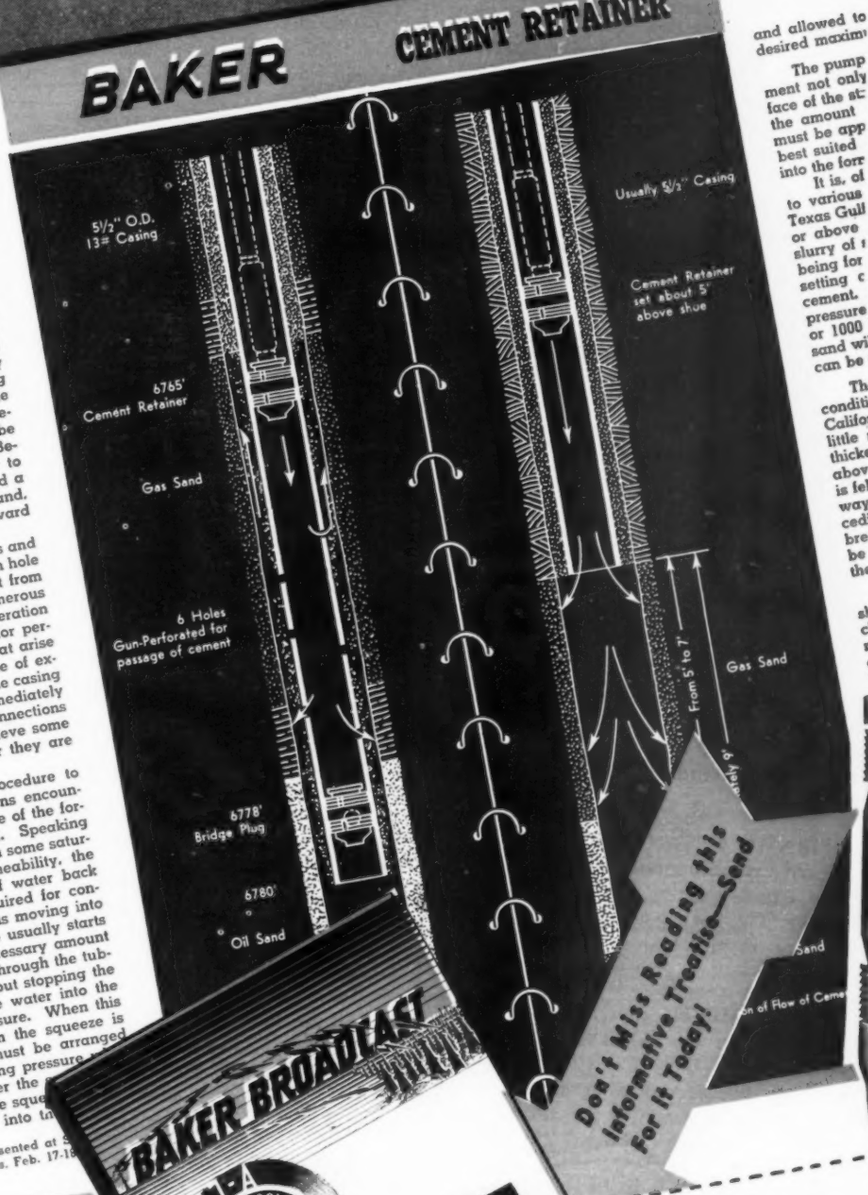
The Many successful Applications For This Unusual Tool Are Described and Illustrated in the New BAKER BROADCAST No. 17-A . . . A 40-Page Booklet Just Off The Press.

Baker Broadcast No. 17-A Gives Detailed Treatment On The Following Subjects:

Squeeze Jobs Solve Many Difficult Problems — *(Reducing Gas/Oil Ratios; Shutting Off Water; Use of Multiple Batches of Cement)* • Recementing Made Sure and Easy • Blank Pipe Can be Cemented At Any Place in the Well • Plugging Can Be Done with Assurance of Success *(Including Plugging Back to Upper Formations)* • Cementing Low Pressure Zones • Using the Cement Retainer for Testing • Cementing Off to Perforate for Production • Cementing Bad Pipe • Cementing Two Strings Together • Use of Tail-Pipe on Cement Retainer

Many Unusual Jobs Done With Cement Retainer

Use of Cement Retainer as Casing Bridge Plug



SQUEEZE JOBS SOLVE MANY DIFFICULT PROBLEMS

In squeeze cementing the slurry is applied to a formation under a pressure that is capable of forcing at least a portion of the cement into the formation to such an extent that it forms an effective barrier to the passage of any fluid (gas or water) from the formation into a well. The application of the slurry may be made in open hole or through perforations in casing but the primary requirements for a squeeze job are that the cement be placed under considerable pressure—which frequently is above 4000 lb. per sq. in.—and that the pressure be maintained without disturbance until the cement has set. Because of the perfect adaptability of the Cement Retainer to meet these requirements, it is quite evident that it has had a great influence on the widespread use of squeeze jobs and, through the facilities which it provides, has done much toward the development of squeeze cementing technique.

Squeeze jobs are now being used in completing wells and in repair work: for shutting off gas and water in both open hole and behind casing or liner either adjacent to or distant from an oil zone; for recementing and plugging; and for numerous applications where specific conditions make the operation "unusual." The advantages of the Cement Retainer for performing squeeze jobs in the great majority of cases that arise are obvious when it is realized that it permits the use of extreme pressures without applying those pressures to the casing and that it maintains the pressure on the cement immediately upon its placement without recourse to surface connections which are not only inconvenient but which may relieve some pressure while being closed in and may leak after they are closed.

Experience has shown that an important procedure to follow in squeeze cementing under most conditions encountered is to break down any obstruction on the face of the formation with water before the cement is applied. Speaking from this experience, C. P. Parsons has stated: "In some saturated-sand formations, or limes of similar permeability, the pump pressure required to begin movement of water back into a formation is usually higher than is required for continuing the movement. After water once begins moving into a relatively tight formation, the pump pressure usually starts dropping. When it reaches minimum, the necessary amount of cement slurry is mixed and pumped down through the tubing and squeezed against the formation, without stopping the flow. The cement slurry thereby follows the water into the formation and starts building up pump pressure. When this pump pressure reaches a desired maximum the squeeze is complete, but the mechanical equipment must be arranged so there will be no material loss of squeezing pressure. When the tubing is being flushed or removed after the squ pump pressure does not build up during the squ ible amount of cement slurry is pumped into t

"Squeeze Cementing" by C. P. Parsons, presented at g. Mid-Continent District, A.P.I., Amarillo, Texas, Feb. 17-18

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Please send me without cost or obligation, your New Baker Broadcast No. 17-A Covering "Use and Applications of the Baker Cement Retainer."

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POSITION _____

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CITY _____

Running Tour
WITH MEN IN THE INDUSTRY

KATSUTOSHI KURODA, assistant manager of the Asano Bussan Company, Tokio, Japan, sailed from Los Angeles, California, recently for company headquarters.

HARRY G. DAVIS, representative for the Gulf Oil Corporation on the board of the Kuwait Oil Company, Ltd., owned jointly by the Anglo-Iranian Oil Company and the Gulf, will return to London this month after a vacation in the United States. He is accompanied by his family.

W. E. LEROUX, division engineer at Ardmore, Oklahoma, for the Carter Oil Company, sailed early this month for Budapest, Hungary. He will be in charge of production for the Standard Oil Company of New Jersey.

HAROLD WYATT, who has been production manager of the San Joaquin Valley division of the Shell Oil Company, has been made assistant production manager of the entire state of California, serving under **F. C. REHM,** general manager. **E. W. MASTERS** assumes Wyatt's former post.

A. S. BAILEY, vice-president and assistant manager of The Texas Pipe Line Company, Houston, Texas, is in Sweden to attend the wedding of his son.

HENRY E. GROSS has been appointed associate professor in petroleum engineering at Texas A. & M. College. The last two years he has been teaching at the University of Oklahoma.

J. W. SMITH, superintendent of production in the Altus area, Oklahoma, for the Gulf Oil Corporation, has been transferred to Indianapolis, Indiana, headquarters for the new eastern division of the company.

D. B. WINES is in charge of the production office recently established in Mattoon, Illinois, by the Tide Water Associated Oil Company. He formerly was at Wichita, Kansas. Assisting Wines are **W. H. CORDELL,** transferred from Robinson, Illinois, and **"RED" FIDLER,** transferred from Wichita Falls, Texas.

C. E. OLMSTEAD, president of The Texas Company of California, Los Angeles, has been elected a vice-president of the parent company, The Texas Corporation. He will continue to serve as president of the California unit and will have offices both in New York and Los Angeles.

A. B. CLARK, Clarksburg, West Virginia, and **W. D. GRIBBLE** and **A. R. THOMAS,** both of West Union, West Virginia, have organized the Empire Oil Company of West Union.

B. E. BODINE, who has been with the Phillips Petroleum Company's refinery at Kansas City, Kansas, has been made superintendent of the Bay Refining Company's plant at McPherson, Kansas, succeeding Claude L. Withers, resigned.

FRANK BRUNER, district superintendent for the Carter Oil Company in the Keokuk area, Oklahoma, has been made superintendent of the North and South Burbank areas, Osage County, succeeding **IVAN S. SALNIKOV,** recently promoted to chief engineer of the company.

BURT R. BAY has resigned as vice-president and general manager of the Panhandle Eastern Pipe Line Company to assume a similar position with the Northern Natural Gas Company. **G. J. NEUNER,** vice-president and counsel, has been chosen by directors to fill the position vacated by Bay.

JAMES T. WOOD, JR., has been made manager of the producing department of The Texas Company of California, succeeding **F. C. SEALEY,** who goes to New York with The Texas Company (Delaware). **R. L. KEYES,** general superintendent, has been promoted to assistant manager. Both men will make their headquarters in Los Angeles. **W. H. FARRAND** has been appointed general superintendent, **H. C. STONE** division superintendent at Santa Paula, and **W. S. ROGERS** assistant to the manager.

WILLIAM B. HEROY has joined Pilgrim Exploration Company as vice-president and chief geologist, according to an announcement by Robert E. McConnell, president, and will make his headquarters at Houston, Texas, where he will devote his entire attention to Pilgrim's oil property interests in Louisiana, Texas, and Arkansas, which are held jointly with Fohs Oil Company. Heroy has been associated with the Consolidated Oil Corporation for 18 years, the last seven of which were as chief geologist and manager of the Foreign Exploration Department. He had previously spent 12 years with the U. S. Geological Survey.

JOHN S. ROSS has recently changed his address from the Bureau of Mines, Bartlesville, Oklahoma, to the Bureau of Mines, Washington, D. C., where he is lending assistance in the final wind-up of the report "Technology, Employment and Output per Man in Petroleum and Natural-Gas Production," a W.P.A. project carried on in connection with the Bureau of Mines.

O. M. WEBB, manager of the International Refining Company plant of The Texas Company at Sunburst, Montana, has been promoted to assistant manager of the Lockport refinery of The Texas Company near Chicago.

LEROY M. HEGBOM, treasurer of the Mene Grande Oil Company, Maracaibo, Venezuela, returned to his home in La Guaira recently following a visit to the United States.

NORMAN E. MAXWELL, Titusville, Pennsylvania, production engineer for the Cities Service Company, has been transferred to Bartlesville, Oklahoma.

W. A. BAKER, JR., chief geologist of the Standard Oil Company of New Jersey in Mexico, resigned July 31. He can be addressed temporarily at P. O. Box 203, Brownsville, Texas.

E. T. MONSOUR, chief paleontologist of the Standard Oil Company of New Jersey in Mexico, resigned July 31, and is now at 1769 Lakeshore Drive, Shreveport, Louisiana.

The extra quality that is built into every detail of Parkersburg Pumping Units is your protection against excessive down time and maintenance costs. This finer engineering and construction will, in a short time, effect savings that more than offset the lower first cost that it's sacrifice would make possible. The truth of this has been discovered by operators all over the country.

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Reinforced sills at anchor bolt foundations.

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Leveling screws in base.

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Split hub cranks with set screws for spreading hub.

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"Banjo" Type Pitmans.

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Split Nuts on engine adjusting screws.

•

Adjustable saddle bearings.

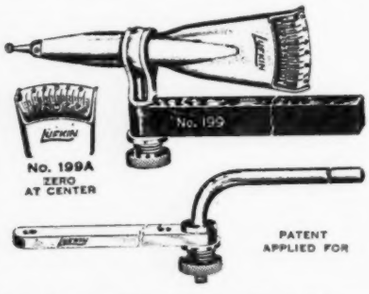
MACHINERY and EQUIPMENT

Universal Indicator

TO its line of precision tools The Lufkin Rule Company, Saginaw, Michigan, has added Universal Indicator No. 199. It has a rotating head, positive lock, and two reading faces; it can be used and read in any practical position, the manufacturers state.

Among its features is the location of the reading faces. As illustrated, one of these is on its front or flat side, the other on the end or top, making this indicator especially suitable for jig-boring, milling-machine, and drill-press work. In such work, the end graduation makes possible reading without a mirror. Also, when used with a surface gauge and vernier height gauge, end reading is the convenient way. Users of indicators recognize that end reading is most natural and handy in a great many of the applications of this tool, the makers assert.

This indicator, which is one unit, makes a complete revolution on its own center and also on the clamping bolt, forming practically a universal joint, all locked in position by one



thumb nut. The frictionally-held contact point can be set at any position in a half circle.

A standard bar for general use and a special attachment for use in drill chuck or surface gauge and with vernier height gauge are supplied with each indicator. The clamping device holds the indicator in position by friction during set-up. It consists of a nut, spring, and washer, held together as one unit.

The housing is tough, rust-proof metal. The contact point and all the working parts are hardened.

No. 199 has zero at extreme left, and reads left to right. No. 199A has zero at center, and reads to left and to right.

A plush-lined case with spring-hinged cover can be supplied.

Low-Alloy Steel Welding Rod

THE Linde Air Products Company, unit of Union Carbide and Carbon Corporation, has announced a new low-alloy steel welding rod, Oxweld No. 32 C.M.S. Steel Welding Rod, for applications requiring welds of particularly high strength. It was developed primarily for insuring uniformly high-quality welds in high-strength steel pipe and plate welded by the Lindeweld process, the manufacturers state. This rod develops an average tensile strength 10,000 to 12,000 lb. per sq. in. greater than rods previously used for pipe welding, yet has sufficient ductility to meet any requirements, the makers assert.

Another characteristic of this new rod is its great resistance to overheating in the molten state, making it particularly suitable for use with the new 4- and 6-flame tips recently developed for Lindewelding pipe lines. The weld metal sets up rapidly, making it easier to control the puddle on a curved or vertical surface. This makes greater welding speeds possible and also effects a reduction in gas consumption per weld, it is stated.

Abercrombie Pressure Gauge

ABERCROMBIE Pump Company, Gulf Building, Houston, Texas, manufacturers of the Fluid-Piston Slush Pump and Shear-Relief Valve, is now producing the Abercrombie Pressure Gauge after rigid field tests in varied classes of oil industry service.

This new gauge for mud, water, oil, air, gas, or any liquid, including slush pump service, gathering line or pipe line service, and Christmas tree installations on flowing wells, is constructed on an entirely new principle, its manufacturers state. It employs no Bourdon tube, is built of extremely rugged parts operating on roller bearings, and offers enduring sensitivity and accuracy, it is asserted. All internal parts operate in oil, a feature assuring the cushioning of the gauge mechanism against external shocks and vibrations, and the prevention of corrosion and wear.

The self-contained diaphragm prevents the line fluid entering any part of the gauge mechanism, an essential requirement of any gauge measuring drilling mud pressure. The self-contained dampening mechanism, which requires no adjustment over the entire pressure range, is designed to give uniformly steady pressure readings where reciprocating pumps are in use, in contrast to the usual needle fluctuations in conventional gauges, according to the makers.

The Abercrombie pressure gauge may easily be read from across the derrick floor and at distances as great as 30 ft., large scale figures and divisions giving long-distance visibility.

The heavy cast-aluminum case is mounted in a forged steel sub that has a threaded connection for screwing directly on the line in which pressure is being measured. The window is of unbreakable plexiglass.

The pressure range is 0-5000 lb. per sq. inch. Descriptive literature, illustrated, tells the entire story of this gauge, and a copy will be sent upon request.

LIFE BEGINS for pump liners

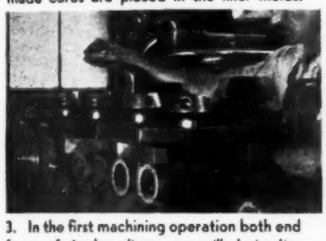
IN AXELSON'S FOUNDRY CONTINUES FOR MANY YEARS IN PRODUCING WELLS

Out of the 103 different manufacturing operations and inspections necessary to the production of finished Axelson Liners these views have been selected to illustrate definite factors. First, these candid views are indicative of complete engineering and manufacturing facilities—second, they express Axelson's painstaking attention to details—third, they exemplify the metallurgical research, the laboratory control and the constant testing carried on as a part of all Axelson Liner manufacturing.

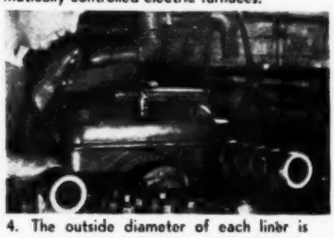
Axelson Liner processes shown are on the regular cast iron only, but Axelson Liners are also available in hardened cast iron, Super-cast iron, Nitri-cast iron and hardened steel Super-Service types. In each will be found design, construction and metallurgical features that make Axelson Liners the oil industry's best buy.

1. Sand molds for liner castings are produced from accurate patterns. Prior to actual pouring operations the previously made cores are placed in the liner molds.

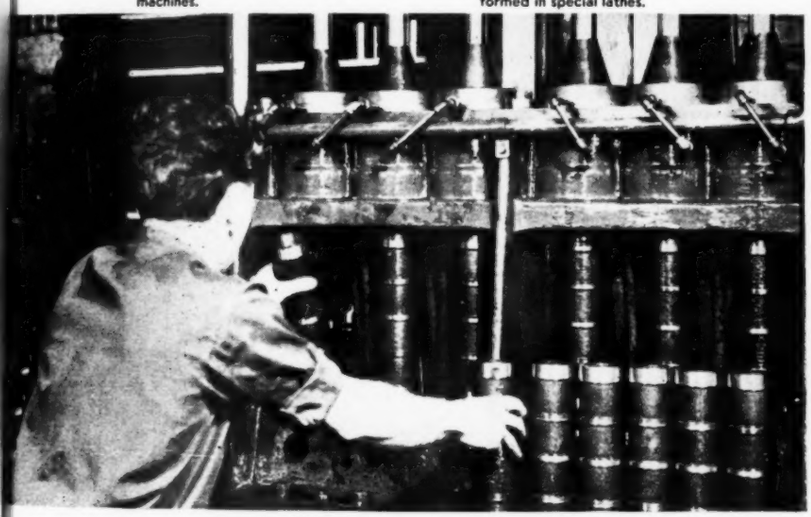
2. Internal strains set up in casting Axelson liners are relieved by a normalizing treatment involving the placing of the castings in automatically controlled electric furnaces.



3. In the first machining operation both end faces of Axelson liners are milled simultaneously in specially tooled duplex milling machines.



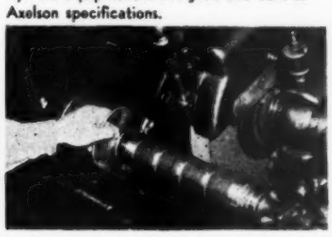
4. The outside diameter of each liner is machined to a predetermined size for subsequent grinding. This operation is performed in special lathes.



5. The internal machining of Axelson liners involves, among others, rough, semi-finish and finish boring operations. For this work special fixtures are used to insure maximum accuracy.

6. High hydraulic pressures are used in testing Axelson liners for any possible porosity. This equipment is designed and built to Axelson specifications.

7. Rough and finish honing of the internal surface of Axelson liners produces not only a high polish but establishes a definite size to A. P. I. specifications.

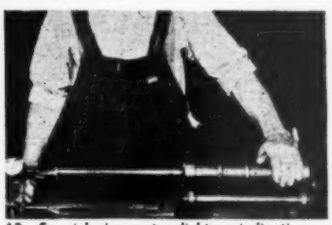


8. The previously turned outside diameter of each liner is now ground to finished size and predetermined tolerances.

9. To establish perfect contact between liners, both ends are faced in lathes. In addition, the liners to be used at the top and bottom of pumps are belled.

10. The corners between bore and end faces are slightly rounded to avoid sharp edges on the finished liners.

11. The internal diameter of each liner is checked with "Go" and "No Go" gauges to verify correctness of machine operations. Visual inspection is made on inside surfaces.



12. Special micrometer dial type indicating gauges are used for checking the entire inside surface for roundness and concentricity with its outside throughout its length.

13. End faces are checked for smoothness with thumb and squareness by using a straight edge in conjunction with a specially lighted background.

14. The liners are cleaned in vapor-type de-greasing equipment and are immersion-coated with a rust-preventive solution.

15. Liners are either boxed for immediate shipment or placed in indexed storage for ultimate pump assembly.

THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY

AXELSON

DEEP WELL PLUNGER PUMPS

SUCKER RODS

Axelson Manufacturing Company, P. O. Box 98, Vernon Station, Los Angeles • St. Louis • 50 Church Street, New York • Tulsa

Mid-Continent and Eastern Distributor: Frick-Reid Supply Corporation • Rocky Mountain Distributor: Great Northern Tool & Supply Company.

Smith Streamlined Petroleum Meter

THE Smith Meter Company, Los Angeles, California, has enlarged its line with a 1¼-in. streamlined meter for gasoline and fuel-oil tank trucks and other uses. Known as Model 3T-40, this meter has a normal capacity of 40 gal. per min. and a maximum safe rate of 50 gal. per minute. Rigid tests prove that it will operate accurately at four gal. per min., according to the manufacturer. It can be supplied either with horizontal reset counter or vertical dial, and also with a set-stop counter and valve for predetermined quantity delivery. For pumpers, a new air eliminator has been developed, which efficiently eliminates all air and gases before they can reach the meter.

This meter, like its companions in the Smith line, is a rotary type without reciprocating or oscillating pistons or valves. By utilizing the rotary principle of metering, continuous flow without restriction or interruption of the liquid stream is obtained, the makers state.

"The design and manufacture of this new meter are such as to insure lasting accuracy throughout its wide range of flow," says Allan A. Floyd, president. "Moreover, this sturdy construction

provides remarkably high resistance to impairment of accuracy by the severe shocks encountered in truck service."

The PROTECTOR that Stays put
Showing details of the tapered locking key—exclusive feature that gives Grizzly Giant its powerful grip on the pipe.
A BEAR for WEAR
Grizzly Giant is the best protection available for drill pipe and casing. The exclusive locking arrangement provides a powerful grip that positively prevents working loose, piling up, or snapping off; and yet can be installed and removed easily by one man. It "stays put" and assures complete protection all the way to bottom in the deepest, toughest wells. Ask your supply company.
E. M. SMITH COMPANY
600-650 South Clarence Street, Los Angeles, California
Complete Stocks Maintained In Our Warehouses At: 1121 Rothwell St., Section 16, Houston, Texas. 1008 S.E. 29th St., Oklahoma City, Okla. Export Office: Continental-Emsco Co., 30 Rockefeller Plaza, New York, N.Y. Distributed by Leading Supply Companies
GRIZZLY GIANT Streamline DRILL PIPE PROTECTOR

Security Lead Seal Packer

THE Security Engineering Company, Inc., Whittier, California, recently developed a new type lead seal packer that is extremely simple in its setting action. It requires no twisting or turning to set, has no slips to jam or get out of order, and eliminates danger of setting the packer in the wrong place, the manufacturers state.

The Security Lead Seal Packer consists essentially of two parts, a hook collar and the packer itself. The hook collar is made-up at the desired position in the casing string, replacing a regular casing coupling. The packer has strong springs around its circumference so engineered that they cannot catch on the casing couplings while the tool is being lowered in the hole. As soon as the packer reaches the specially-formed recess of the hook collar, however, the springs instantly expand and lock the packer against any further downward progress. Then it is only necessary to lower the run-in string straight downward against the springs, expanding the packer and forming a fluid-tight seal.

When the packer is to be removed a straight lift only is required to pull the springs free and allow it to be quickly withdrawn from the hole.

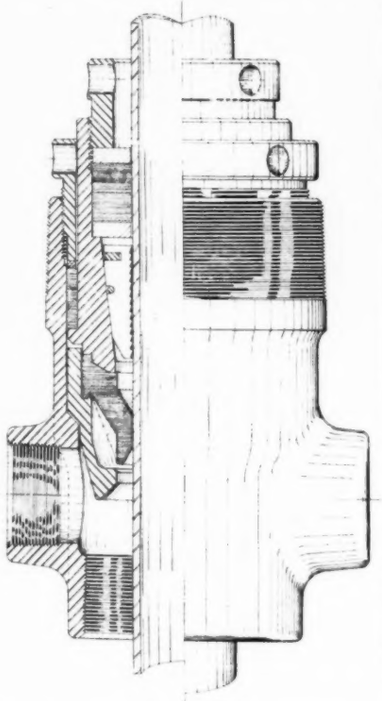
A special circulating joint can also be run with the packer for multiple production work, or wherever it is desired to establish circulation between production strings. This joint has two long slots on opposite sides of the body, and when the run-in string is lifted these ports are opened, allowing circulation to be established between the inside and outside of the string. When the run-in string is lowered the joint telescopes, closing the ports and automatically making a fluid-tight seal against a lead ring.

The Security Lead Seal Packer and Circulating Joint are made both in conventional steel construction and of "Securaloy," the drillable metal. When made of drillable metal everything except the short spring fingers can be made of "Securaloy," and these springs, being small, can either be readily pushed into the walls or picked up with a basket bit.

The Security Lead Seal Packer and Circulating Joint are available in a wide range of sizes to fit every production need, it is asserted.

National Tubinghead

THE Type OH-1 stripper tubinghead, which permits the raising and lowering of tubing under pressure, has been placed on the market



by The National Supply Company, Toledo, Ohio. The stripper rubber is at the lower end of the spider. It automatically seals around the tubing, being forced into contact with the pipe by pressure from the well. The sealing effect is entirely automatic and is independent of endwise pressure on the rubber. Being unconfined the rubber is free to stretch, which reduces the likelihood of damage from sharp couplings. Radial ribs stiffen the rubber so that it will withstand high pressures. These ribs do not materially affect the flexibility but permit the rubber to stretch freely around couplings.

The lower guide is an exclusive National feature. This centers the tubing couplings as the tubing is raised. The tubing couplings are prevented from pressing against the lip, lessening the danger of torn rubbers while raising tubing. All joints are packed with Duprene packing. The packing rings are relatively narrow and can be sufficiently compressed by screwed glands to withstand high pressure. The tubing is supported on slips. This feature makes the head suitable for use on wells that have tubing packers. All bodies have emergency threads at the upper end, which permit attaching blowout preventers.

YOUR CREWS WILL LIKE THIS BETTER LINING...

ASBESTOS "CABLES" form the backbone of J-M 420 Rotary Lining. Woven into a compact mass, impregnated and compressed, they make a remarkably efficient and durable lining for heavy-duty work.

IF you've used J-M Rotary Linings . . . and most producers have . . . you know they give smooth, sure braking for a long time at low cost. But here's a *new* J-M Rotary Lining that gives even better service. It's made from an improved weave of "cabled" asbestos yarn, impregnated to increase heat resistance and frictional qualities, and it has these important advantages:—

HIGHER BRAKING EFFICIENCY, even at extreme temperatures caused by heavy loads . . .

LONGER LIFE under any conditions . . .

LESS SCORING of drums, giving longer drum life.

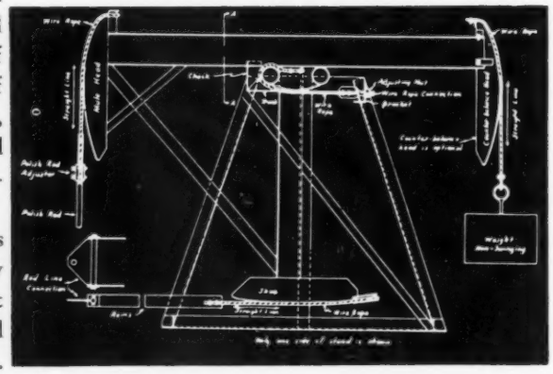
Your own drilling rigs will prove the superiority of J-M 420 Rotary Lining. For complete information on this improved lining and on all J-M Friction Materials, write Johns-Manville, 22 East 40th St., New York City.

JM JOHNS-MANVILLE 420 ROTARY LINING

A-Y Bearingless Jack

THE A-Y Bearingless Jack is a patented product of the A-Y Manufacturing Company, Wichita Falls, Texas. This new no-bearing principle requires less power to operate, and eliminates swing and sway, the makers state. Another feature is the speed with which the jack can be made ready to pull the rod, but two minutes being required.

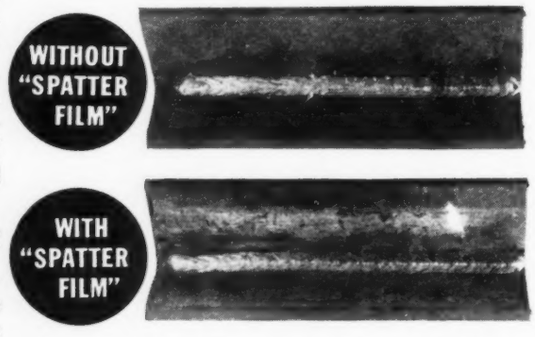
The ease with which this jack can be serviced and repaired is an outstanding advantage, it is stated. Any pumper can repair it, the only material needed being a section of wire line. The frame of the jack is made of sturdy, arc-welded structural members, carefully balanced and designed.



A-Y Bearingless Jacks are distributed exclusively by the Mid-Continent Supply Company, general offices, Fort Worth, Texas.

Compound Facilitates Cleaning After Welding

A NEW compound, which is said to reduce cleaning time after welding by 20 to 60 percent, is announced by The Lincoln Electric Company, Cleveland, Ohio, manufacturer of arc-welding equipment and electrodes.



This new compound, known as "Spatter Film," has been developed by Lincoln engineers to increase the economy of electric welding as a process of manufacture and fabrication. By reducing the tendency of spatter to adhere tightly, thus facilitating its removal (see illustration), "Spatter Film" makes fabrication by arc welding still more economical, it is asserted. The savings resulting from use of the compound will be particularly apparent in work where painting and finishing are essential.

"Spatter Film" is soluble in water. It is non-inflammable and contains no free alkali to injure the hands or harm paint. It is easy to apply by means of an ordinary paint brush. Only sufficient film need be applied to cover the work adjacent to the seam or joint. A gallon of "Spatter Film" will cover appropriately 50,000 sq. in. of surface. It can be removed readily by wiping with a clean cloth if still wet, or by washing with water if dry.

Time to clean welded work consisting of a 10-in. single-bead fillet weld joining two pieces of 12-gauge plate, using 5/32-in. electrode, was .84 minutes using the compound, as compared with 1.04 minutes without it. For a 9-in. single bead, joining ¼-in. flat steel plates, using 3/16-in. electrode, cleaning time with "Spatter Film" was .58 minutes; without, 1.54.

Youngstown Union Check Valve

A SPRING - CONTROLLED, forged-steel union check valve for the petroleum industry is announced by The Youngstown Sheet and Tube Company, Youngstown, Ohio. Designed for full pipe capacity, the valve is built for a steam working pressure to 600 lb., or a cold working pressure to 2000 pounds.

The spring controls the opening and closing of the valve in accordance with the velocity of the flow yet is so designed that it is not affected by sudden fluctuations of flow or back pressure, the manufacturers state.

The valve has a hylastic vanadium cast-steel body, a tensile strength of 103,000 lb. per sq. in., and poppet and seat of high-temperature and corrosion-resisting bronze known as U. S. Navy Bronze 88-10&2. The spring is made of phosphor bronze and will retain its tension at temperatures to 650 deg. fahrenheit. The valve can be used in any position, vertical, horizontal, or inverted.

Poppet, seat, and spring are heavily chrome plated to resist the corrosive action of crude oil and acids. Examination and replacement of poppet, seat, and spring can be made without removing the valve from the line.

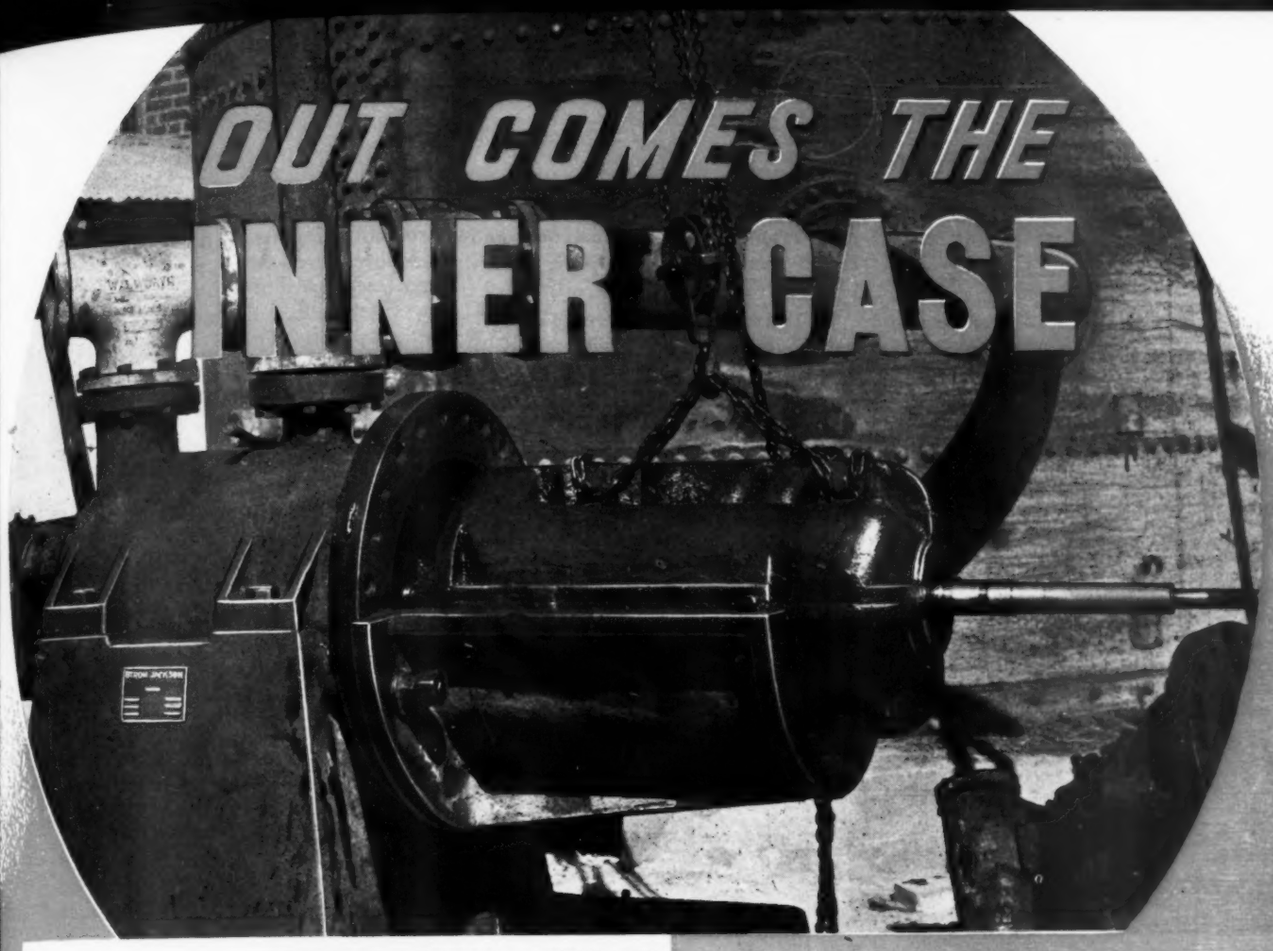
The union check valve is made in three sizes for 2-, 2½-, and 3-in. pipe and is supplied either with standard or handle bar nut.

Announces New Diesel Engine

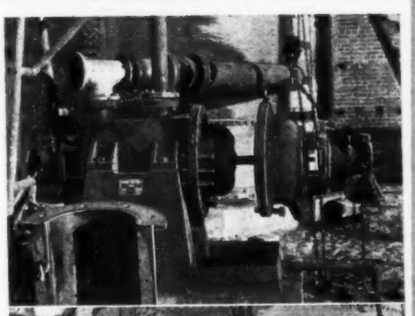
ADDING to its line of industrial Diesel engines Caterpillar Tractor Company, Peoria, Illinois, has announced a new 6-cylinder, 66-hp. model, designated as the D4600.

The new engine has a bore and stroke of 4¼ in. by 5½ in., and turns at 1400 r.p.m., normal governed speed. Exceptionally smooth running and unusually flexible, the model is well suited for use in shovels, draglines, and hoists, or connected to a generator as an electric power producer, the manufacturers state.

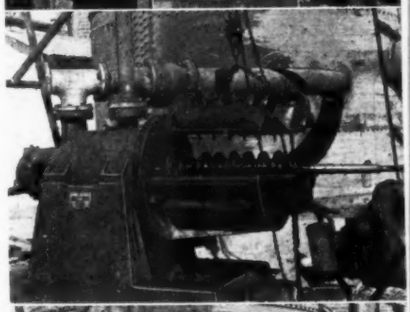
The engine is of the four-stroke-cycle, valve-in-head, water-cooled design, and features solid injection of the fuel into precombustion chambers. The fuel injection system is similar to that of all "Caterpillar" Diesels. Both the injection pumps and injection valves are set at the factory, and require no field adjustment.



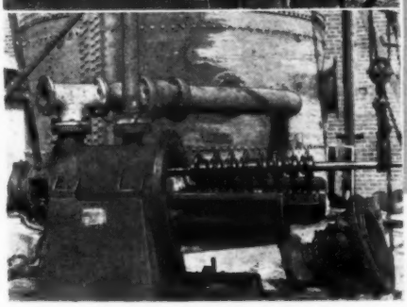
As the first step in dismantling, the End Cover and Bearing Housing are removed without disturbing Piping or Driver. The second step is shown above.



The completely assembled Rotating Element is ready for removal. Dismantling Tray is bolted in place and upper half of Inner Volute Case has been lifted.



Ready for removal of Rotating Element to the machine shop, after which the spare Rotating Element is dropped into position and the pump readily reassembled.



BYRON JACKSON DOUBLE-CASE HOT OIL CHARGING PUMP . . .

. . . with Dismantling Tray bolted in position supporting the *complete* Inner Volute Case and Rotating Assembly here *being removed as a single unit*. Notice the large amount of coke present, in spite of which the Inner Volute Case is easily removed due to the irregular sections which permit breaking away the coke. The Byron Jackson design eliminates all close clearance points which cause binding.

Attention is called to the fact that neither the Piping nor the Driver has been disconnected or disturbed in any manner.

Details will be furnished upon application.

Established 1872

BYRON JACKSON CO.

Dept. O-55

Factories at: **Berkeley and Los Angeles, California**
Bethlehem, Pennsylvania

Sales offices: **New York, Pittsburgh, Fort Worth, Chicago, Atlanta, Houston**

Established 1872

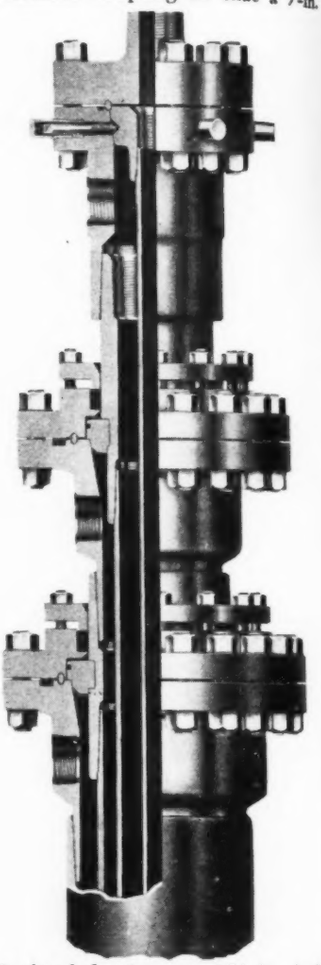
BYRON JACKSON

CENTRIFUGAL PUMPS FOR EVERY SERVICE

Rector Extended Recessed Coupling

RECTOR Well Equipment Company, Fort Worth, Texas, now manufactures an extended recessed coupling that gives the combination of Rector casinghead and Rector tubinghead the effect of an integral unit. This recessed coupling embodies the exact principle of the recessed coupling in Rector casingheads, yet is extended in length to permit screwing the tubinghead directly on an outside thread, thus eliminating the use of an extra nipple under the tubinghead and thereby removing a weak point in surface control hook-ups.

This extended recessed coupling permits mounting a 10,000-lb.-test tubinghead directly on the recessed coupling. The manufacturer explains that it retains the repackable feature of Rector Heads not feasible with spool-type construction. The thread used in landing pipe is not used as a permanent connection when the extended recessed coupling is used, because the coupling also has an inside thread for landing purposes. A safety thread is provided below the Christmas tree for unscrewing and stabbing over, in case of a wild well. On a 7-in. oil string an 8⅝-in. outside thread is provided on the recessed coupling so that a 7-in.



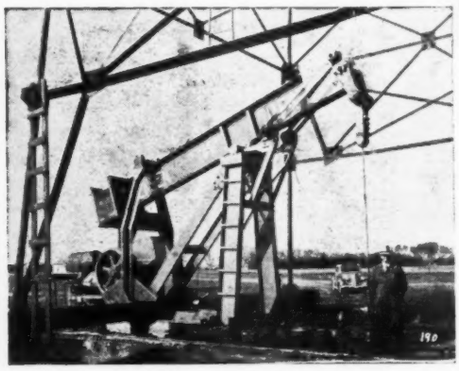
tubinghead having an 8⅝-in. inside thread may be used. On 5-in., 5½-in., and 5¾-in. oil strings an outside thread is provided on the recessed coupling, either V-type, rounded, or any of the customary square threads, at the purchaser's option.

The extended recessed coupling makes the combination of Rector casinghead and tubinghead far more compact and rigid, the makers state.

Lacquer Spray and Solvent Hose

UNITED States Rubber Products, Inc., New York City, has announced its new U. S. Peerless Lacquer Spray and Solvent Hose—OFF. P-243-Synthetic Lined.

Lacquer and synthetic enamel sprays usually contain butyl acetate and other solvents whose action is destructive to rubber, but this new hose has proved itself superior for this purpose, it is claimed.



CHEAP OIL

Nineteen years ago we became intensely interested in how to cut the cost of lifting oil. We've worked at nothing else and have been interested in nothing else through all these years.

JENSEN BROTHERS MANUFACTURING CO.

. . . Coffeyville, Kansas

Everything we have learned is incorporated in JENSEN Straight-Lift JACKS. They make oil almost as cheap on TOP of the ground as it is in the bottom of the hole. We'd like to tell you exactly what these units would do for you.

NEW! The Type NRM 124 LINK-BELT *Vibrating* SCREEN

● This new unit is recommended for shallow and medium depth drilling rigs. Present performances show it capable of handling the discharge from a pump as large as 7¼" x 18". Designed to incorporate all of the features of the standard Link-Belt mud screen, including fine mesh stainless steel screen cloth, rubber cushioned; adjustable feed; enclosed vibrator unit; unitized collecting tank; self-contained drive, etc. More economical in price and maintenance. Send for complete details. 7470

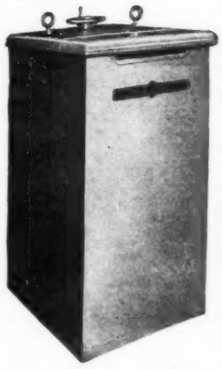
LINK-BELT COMPANY

Philadelphia Houston Tulsa Dalla
Los Angeles New York

FOR SHALLOW to MEDIUM DEPTH DRILLING RIGS

G-E Atomic-Hydrogen Welding Equipment

NEW atomic-hydrogen arc-welding equipment, especially suitable for the welding of special alloys and thin sections difficult or impossible to weld by other methods, has been announced by the General Electric Company, Schenectady, New York. The equipment is particularly useful when a fusion weld is required; it produces a uniformly strong weld, free from porosity, and with an exceptionally smooth appearance, the manufacturers state. Some common specific applications are: the building up of broken or worn sections of molds, tools, and dies; the addition of a different metal for hard surfacing and other special requirements; and the welding of light-gauge stainless steel.



In atomic-hydrogen arc-welding, an a-c. arc is maintained between two adjustable tungsten electrodes, and at the same time hydrogen gas is fed to the arc and around the electrodes. The hydrogen molecules that are subjected to the intense heat of the arc are broken up into atoms. Most of these atoms, recombining outside the arc zone, in contact with the work, liberate heat far in excess of that obtainable from a gas flame or from an electric arc alone, it is stated.

The remaining atomic hyrogen provides an extremely active reducing atmosphere that effectively prevents oxidation and other contamination of the weld metal, reduces surface oxidation on the parent metal, and protects and cools the tungsten electrodes, thereby minimizing electrode consumption.

As the work does not enter into the electric circuit, it need not be grounded.

A suitable filler rod can be fed into the weld when needed.

The new G-E equipment combines into a compact, portable unit, all the electric devices used with the process. Convenient terminals and pipe fittings allow ready connection to the electrode holder, to the power supply, and to the hydrogen source.

A convenient, easily-operated handwheel on the top of the set controls a continuous variable reactor that gives stepless current adjustment to any one of an infinite number of settings, permitting the use of the correct current for every job. An ammeter indicates the amount of current being used.

The drip-proof enclosure protects the equipment and the operator. Ventilation is provided by louvers at the ends. Lifting eyes facilitate transportation by crane. Roller-bearing wheels can be added to make the unit even more easily portable.

For hand welding the familiar rod-type electrode holder and suitable power and hydrogen connections are provided, together with a supply of tungsten electrodes of the correct size.

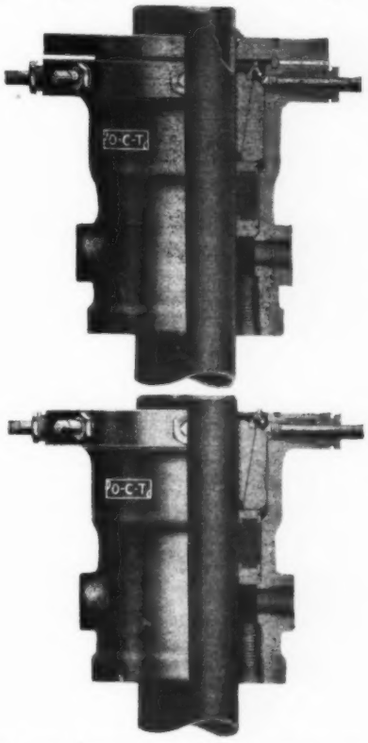
For automatic welding, equipment having either a single- or multiple-arc head can be supplied, together with the necessary control, means for holding the work, and traveling mechanism.

O-C-T Slip-Type Casinghead

OIL Center Tool Company, Houston, Texas, recently placed on the market a new slip-type casinghead, designated as type "C-9-PS," and designed to permit hanging of casing at any desired point through blowout preventer equipment.

The accompanying illustrations clearly show the design of this new head. After running casing to the desired suspension point, split packing rings of Neoprene and slips are lowered into the head body and casing is suspended. Weight of the casing string is transmitted through the slips and slip bowl to compress the packing below the slips. Making up on hold-down screws forces the slip bowl downward against the packing to aid in effecting a seal.

The O-C-T type "C-9-PS" casinghead is available with or without a welding flange at top, as illustrated, which provides a means of holding the



casing down as well as serving as a secondary seal above the slips. The flanged top accommodates a flanged-type tubinghead.

The O-C-T type "C-9-PS" casinghead is available in all sizes and in test pressures to 10,000 pounds.

Pinch-Hitter

FOR THREADS

RECTORSEAL, the new discovery thread compound, prevents leaks on all oil industry connections, whether on new or old pipe. It is insoluble in all petroleum products, yet has a high lubricating value so that threads make up readily and break out with no cementing action. One gallon treats threads on 2000 feet of 7-inch casing. RECTORSEAL is virtually a rebuilder of damaged or worn threads, even against high pressures.

Smear sample for your examination sent free, upon request.

A Product of

Buy it at your Supply Store in 1-Gal. Pails

RECTOR WELL EQUIPMENT CO., INC.

HEADQUARTERS: Fort Worth, Texas. BRANCHES: Houston, Wichita Falls, Midland, Corpus Christi, Los Angeles, Tulsa, Shreveport, Casper.

The New

"HUF M-T-L"

Insert Pump

THE new Huf M-T-L Rod Pump comprises a grooved alloy-iron sectional plunger. The pump is installed and removed with the rods, without pulling tubing.

A number of improved features combine to give the Huf M-T-L Pump a longer service life and very efficient operation. The plunger sections are made from a corrosion-resisting alloy iron, heat-treated for greater resistance to wear; the precision barrel tube is of cold-drawn seamless steel. All pumps are equipped with "Repelex" Stainless Steel Balls and Seats as standard equipment.

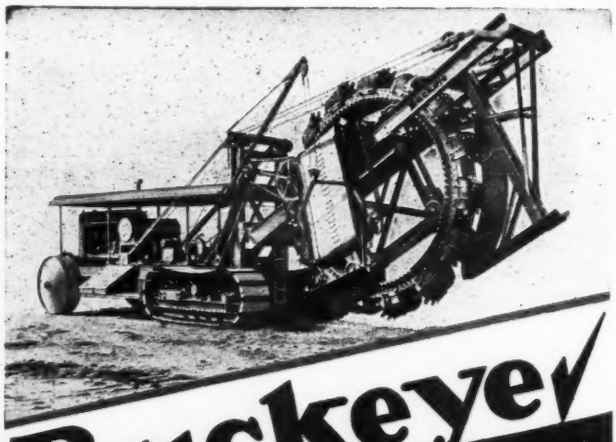
Sizes are:

2" x 1½"—2½" x 2"—and 3" x 2½"

Write for free Bulletin 1-A, which gives complete details and prices of the Huf M-T-L Insert Pump.

THE CHAS. N. HOUGH MFG. CO.

Franklin, Pa. **Tulsa, Okla.**



Buckeye

. . . DIGS the DITCH

Buckeye Ditchers are used on pipe line work the world over because the men who build pipe lines know that they can depend upon Buckeye Ditchers to get the job done - on time - and at the lowest year around cost. Experience proves it.

THE Buckeye Traction Ditcher Co.

FINDLAY, OHIO

BID THE Buckeye WAY • ask for our operation data before you bid

Tank Deck Float Controls Water Level on Wooden Tanks

A NEW Black, Sivalls and Bryson product is the Tank Deck Float, a device for controlling the water level on the top of wooden tanks. Working on the same principle as the float in the toilet tank, the B. S. & B. tank float releases sufficient water to offset evaporation or other loss of

water and keeps the water level at whatever height the operator desires.

The operator simply lays a water line to the top of the tank and mounts the valve and float as shown in the accompanying picture. The float and valve will do the rest—and do it automatically, assert the manufacturers. Men may forget or be too busy to attend to tank deck water conditions, but the float won't need any attention.

Link-Belt Unmounted Roller Bearings

LINK-BELT COMPANY, Chicago, Illinois, has placed on the market a complete line of Link-Belt Shafer radial-thrust single-row and double-row roller bearings in the naked or unmounted form, and a new booklet, No. 1652, 12 pages, complete with engineering data for figuring applications, has been prepared for distribution. The text of the booklet stresses:

1. Free rolling action and unimpaired loading capacity, even in the presence of shaft deflection or misalignment, is assured.

2. No provision for misalignment need be made in the bearing housing or mounting.

3. Thrust capacity is provided by the roller and raceway shapes and by the angular position of the curved rollers between curved races.

4. Radial or thrust or any combination of radial-thrust loads will be carried equally well and on the same full contact area under all conditions of alignment.

5. There is no possibility of rollers pinching or binding, and no need for auxiliary means of taking the thrust.

The new booklet gives dimensions, weights, load ratings at 500 r.p.m., and list prices, for both single-row and double-row bearings.

Engineering data, such as determination of radial load, load ratings, modifying factors, life factors, operation factors, speed factors, and formulae and examples covering all types of loading, also are included.

A copy of Booklet No. 1652 may be obtained by writing to Link-Belt Company, Chicago, Philadelphia, Indianapolis, or other offices.

Trade Personals

T. J. FLANAGAN, president of the Gaso Pump and Burner Manufacturing Company, Tulsa, Oklahoma, left with his family recently for a month's vacation in Cuba.

J. S. WARREN, general manager of the Maloney Tank Manufacturing Company, Tulsa, Oklahoma, left early in August for a two weeks' vacation. He and Mrs. Warren drove to Highlands, North Carolina, making stops en route at Louisville and Lexington, Kentucky.

J. B. O'CONNOR, vice-president and director of sales of Clark Bros. Company, Olean, New York, is back at his desk after a vacation with his family in Western Canada. O'Connor's family is returning to New York from Vancouver Island by steamship, via the Panama Canal.

F. M. PAUL, advertising and sales promotion manager of Air-Maze Corporation, Cleveland, Ohio, announces the appointment of H. B. CLEVELAND, San Francisco, as Air-Maze factory representative for San Francisco and northern California.

W. D. MOORE has been appointed manager of the well processing division of the W-K-M Company, Houston, Texas. Moore has been connected with the oil industry directly and indirectly for the last 18 years, having invented and put into service many items used in drilling and production.

M. J. FLANAGAN, vice-president of the Gaso Pump and Burner Manufacturing Company, Tulsa, Oklahoma, and Mrs. Flanagan are spending a month's vacation in California. They left Tulsa recently for San Francisco, and will visit a number of California resorts during the month they are away.

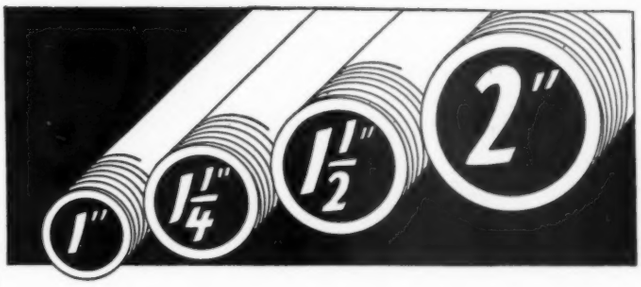
GLENN SKINNER, vice-president of Black, Sivalls and Bryson, Inc., Oklahoma City, Oklahoma, is touring Europe with his wife and daughter, visiting Germany, France, England, Italy, Switzerland, and Scotland.

ALLAN J. EDWARDS, Tulsa, Oklahoma, sales manager for Black, Sivalls and Bryson, Inc., returned recently from a combination business and vacation trip through the eastern part of the United States and Canada. Mrs. Edwards accompanied him on the trip.

NORMAN R. DOWNIE, formerly engaged in the sale of wire rope in the New York sales district, Bethlehem Steel Company, has been transferred to the home office at Bethlehem, Pennsylvania, and will assist C. M. Ballard, manager of sales, wire rope.

THOMAS WEISKOPF, formerly assistant superintendent, has been appointed superintendent and FRANK A. GARVEY assistant superintendent of the Massillon, Ohio, plant of the Union Drawn Steel Division, Republic Steel Corporation, Cleveland, Ohio. Garvey for the last 18 months has been engaged in special engineering work for the Union Drawn Steel Division.

E. M. SMITH, president of the Emsco Derrick and Equipment Company and affiliated interests, has returned to Los Angeles, California, after a six weeks' trip through the Mid-Continent area studying conditions. It is his intention to spend a couple of weeks looking over the California fields, going then to Houston, Texas.



Thread 'em all with 1 Set of Chaser Dies

in this speedy bother-saving RIDGID No. 65R

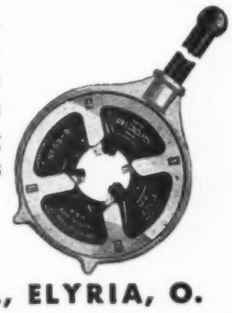
Now made in powerful new construction

Only 4 chaser dies instead of 16 — and they stay in the threader. No bother changing, no extra pieces to lose. Saves you time and expense!

Just a quick shift of the setting post and this No. 65R is ready to cut perfect threads on 1″ to 2″ pipe, any metal, all thread variations. Saves you work!

Speedy new style work-holder clicks to pipe size, tightens with one screw. No bother with bushings!

You like the "feel" of this tool, the handsome appearance that inspires pride and care, rugged metals that stand the gaff, many features that give you faster easier threading —and real economy, as thousands of users can tell you.



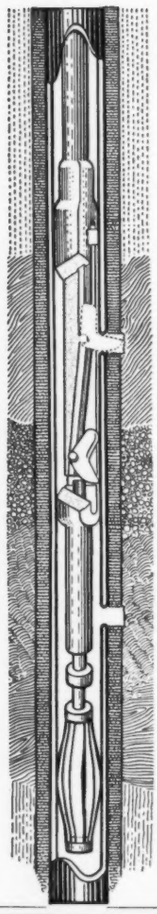
Buy from your Supply House.

THE RIDGE TOOL CO., ELYRIA, O.

Stop Pipe Wrench Housing Repairs

That guarantee saves you fully 75% of your pipe wrench repairs. Buy the RIDGID.

RIDGID PIPE TOOLS



A CLEAN CUT
right through the casing

Shull Casing Perforators embody patented principles found in no other tools. Perforations can be punched in the casing in the well with the highest degree of accuracy without danger of collapsing or weakening the casing.

SHULL 1- and 2-STRING PERFORATOR

Inclined channels in the main body provide positive operation of the cutting blade and a direct clean punch which forces the blade, shear-like, through the single or double casing, penetrating the cement. A drop-away feature indicates when hole is punched. Complete elimination of ripping of casing. Assures a clean perforation job.

The New Shull Catalog Tells All About It . . Request a Copy

SH"LL PERFORATING CO., INC.
2750 Cherry Ave. Long Beach, Calif.

Look for the *Arm-and-Hammer*

ARMSTRONG BROS.

RECEDING TYPE THREADERS

CHASERS are made of Special Vanadium Tool Steel with "backed-off" hob-cut teeth, they make cutting faster, easier, smoother. Hardened, drawn, tempered, and tested they are free cutting and long-lived—hold their keenness. Accurate in form they assure tight threads. Plainly marked, they fit all standard threaders of this type.

ARMSTRONG BROS. improved threaders are designed to give perfect threads with minimum effort. Bodies are of Certified Malleable Iron, are rust-proofed with cadmium plate. No. 1 STANDARD and No. 1A RATCHET types are furnished with either ring guides or improved self-centering pipe holders. For from 1 to 2-inch pipe. No. 2 GEARED Threader is for 2½ to 4 inch work.

Write for Catalog

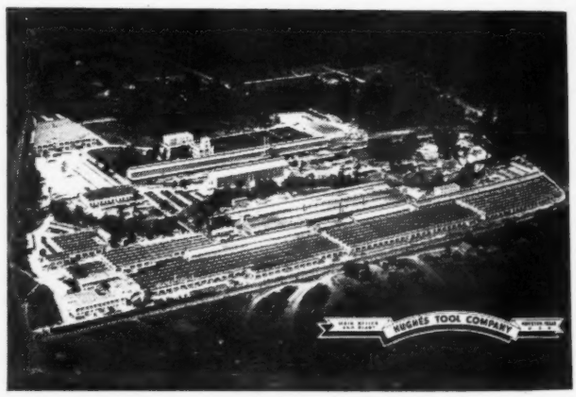
ARMSTRONG BROS. TOOL CO. "The Tool Holder People," 331 N. Francisco Ave., Chicago, U. S. A.
Eastern Warehouse and Sales:
199 Lafayette St., New York
San Francisco London

Houston Fetes Howard Hughes After World-Circling Flight

Howard Hughes, the petroleum industry's own, who with his crew of four smashed the round-the-world flight record, was given an ovation seldom accorded kings and presidents when he returned to his "home town" of Houston, Texas, July 30.

The initial honor came when, met at the airport he was informed by Walter B. Pyron, vice-president of the Gulf Oil Corporation and chairman of the aviation and advisory committees of the Houston Chamber of Commerce, who acted as master of ceremonies, that henceforth the airport would be known as Howard Hughes Field. Following this there was

Howard Hughes immediately after landing at the Houston airport named after him



Plant of the Hughes Tool Company founded by Howard Hughes, Sr.

a parade that beggars description, an afternoon smoker, and as a climax a banquet attended by numerous men of prominence in the state and union.

At the banquet Governor Allred made Hughes a colonel on his staff and presented him with a commission as Texas' representative to the World's Fair in New York and the San Francisco Exposition.

Despite the honors heaped upon his head Hughes, with characteristic modesty, disclaimed any personal accomplishment in the round-the-world flight.

"Anything I have done which you may consider worth-

while has been made possible by the genius of my father, and the men who compose the various parts of the company he created." (Referring to the Hughes Tool Company.)

"Our flight," he continued, "was merely the extension around the world of the operating technique used by the air lines of this country. The flight from beginning to end was by and in accordance with the procedure now in use by the air lines.

"The plane was not designed by me or any member of my crew. It is just the plain, ordinary ship most of you use in flying from city to city in the United States. All we did was put in a couple of extra gas tanks. I didn't have anything to do with building it. I didn't have much to do with flying it, even, because it practically flies itself."

Three Service Records

Norton McKean

Members of the present management and sales personnel of American Meter Company are extending congratulations during 1938 to three associates for their service records.

A. E. Norton, manager of the Nathaniel Tufts Meter Works of American Meter Company in Boston, and a member of the board of directors, first joined the company on July 1, 1898.

W. H. Kaiser, joining Metric Meter Works, Erie, Pennsylvania, in 1898, became foreman of that American Meter Company plant in 1904, master mechanic in 1916, and superintendent in 1926.

W. H. Kaiser

A. E. Norton

Norton McKean, who joined the Boston plant on July 14, 1913, completes a quarter century of affiliation with American Meter Company. He became assistant manager of D. McDonald and Company Works in Albany in 1925, manager in 1928, a member of the board of directors in 1932, general superintendent in 1936, and vice-president in 1937.

Broderick and Bascom Purchase Business and Patents

The Broderick and Bascom Rope Company announces the purchase of the business and patents of the Murray Safety Sling Company of Pittsburgh, Pennsylvania. D. Murray, who is the original manufacturer of plaited wire rope safety slings, has sold his patents to the Broderick and Bascom Rope Company and will himself join this company, being in charge of the Murray Safety Sling Division factory at 33 Water Street, Pittsburgh, Pennsylvania.

The business will of course be handled through Broderick and Bascom's main office at 4203 North Union Boulevard, St. Louis, Missouri, and through their branches and distributors throughout the United States.

Keeps Discharge Constant— Full-Speed Operation Safe

As a close regulator of pressure on constant-speed pumps, the C-F Compressor Regulator has no equal. Thoroughly dependable in all applications where such a device is needed. Excess discharge pressure flows through and is relieved with no appreciable variation in the suction line. Lever-type regulator is here shown. Spring-loaded type is also available and is equally sure-working. Ask for Bulletin No. 130, also for catalog of all Chaplin-Fulton Regulators.

CF

COMPRESSOR REGULATOR

The

CHAPLIN-FULTON MFG. COMPANY

28-40 Penn Avenue Pittsburgh, Pa.

Principal features of the

B-M-W Tex Type Working Valve

Exceptionally long runs are obtained with B-M-W Tex Type Working Valves because of their outstanding ability to withstand wear and the cutting action of sand.

Complete Data on Request

WHERE OBTAINABLE? B-M-W Products, all obtainable at supply stores, include: • TEX TYPE Plunger Fittings and Valves; • ADMORE Insert Pump Anchors; • NEILSON Tools (Safety Sucker Rod Hooks, Tubing Hooks, Rod Elevators, Sucker Rod Sockets, etc.); • BALLS and SEATS (made for every pumping service); • ADMORE Liner Barrels; and • COLLINS Belt Clamps.

BRADFORD MOTOR WORKS INC.

OIL WELL SUPPLIES

BRADFORD, PA. — TULSA, OKLA.

A time-worn adage, however, as true today as when first uttered. Especially when applied to National Hotels.

Enjoy the BEST in hotel services by a TEST of our Thirty-four modern units comprising the

Affiliated **NATIONAL HOTELS**

ALABAMA
THOMAS JEFFERSON ..... Birmingham

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HOTEL FAUST ..... Rockford

LOUISIANA
JUNG HOTEL ..... New Orleans
HOTEL DESOTO ..... New Orleans

MISSISSIPPI
HOTEL LAMAR ..... Meridian
HOTEL RIVIERA ..... Biloxi

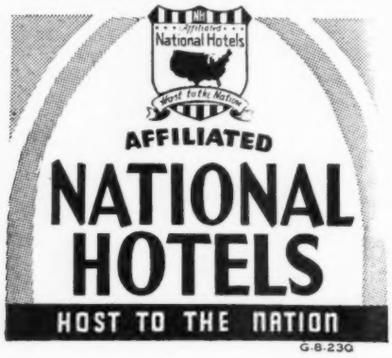
NEBRASKA
HOTEL PAXTON ..... Omaha

NEW MEXICO
HOTEL CLOVIS ..... Clovis

OKLAHOMA
OKLAHOMA BILTMORE ..... Oklahoma City
HOTEL HUBER ..... Muskogee
HOTEL BELMONT ..... Okmulgee
HOTEL SAPULPA ..... Sapulpa
HOTEL ALDRIDGE ..... Wewoka

TEXAS
STEPHEN F. AUSTIN ..... Austin
HOTEL SETTLES ..... Big Spring
HOTEL BROWNWOOD ..... Brownwood
HOTEL SOUTHERN ..... Brownwood
HOTEL LAGUNA ..... Cisco
HOTEL CLIFF TOWERS ..... Dallas
HOTEL DONNA ..... Donna
HOTEL CORTEZ ..... El Paso
HOTEL TEXAS ..... Fort Worth
HOTEL BUCCANEER ..... Galveston
HOTEL JEAN LAFITTE ..... Galveston
CORONADO COURTS ..... Galveston
MIRAMAR COURT ..... Galveston
HOTEL CAVALIER ..... Galveston
HOTEL LUBBOCK ..... Lubbock
HOTEL FALLS ..... Marlin
HOTEL GHOLSON ..... Ranger
HOTEL CACTUS ..... San Angelo
ANGELES COURT ..... San Antonio

VIRGINIA
HOTEL MOUNTAIN LAKE ..... Mt. Lake

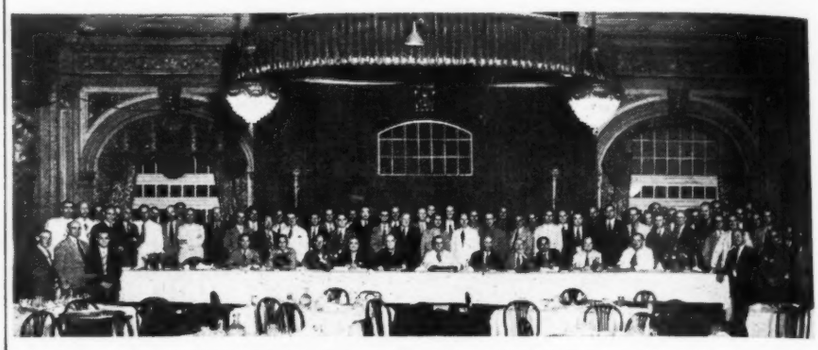


G-8-23Q

Exhibiting Space in Demand for Houston Oil Show

Display of equipment for every branch of the oil industry is already assured for the next Oil-World Exposition, to be held in Houston, Texas, made necessary the provision of considerably more land than was used at the previous show. The additional area is adjacent to the main building.

A corner of the main exposition building, just off the business district of Houston

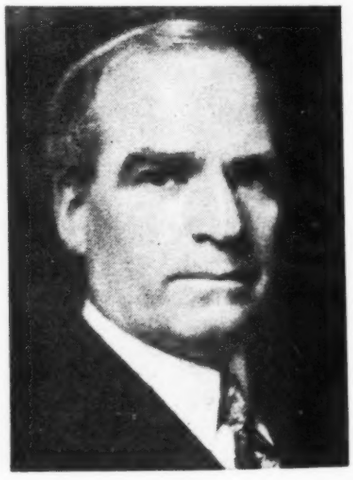


Annual meeting and election of Oil-World Exposition, Inc.

April 24 to 29, 1939, according to Ed Lenzner, general manager. In addition to the extensive outdoor space that has been reserved by manufactureres having heavy equipment for demonstration, 400 spaces in the main building and annex have been reserved.

Indoor exhibiting facilities have been increased by an annex that extends the main floor of the Coliseum, providing an additional 45,000 sq. feet. Additional inside space is also being made available on the ground floor of the main building, which will provide another 45,000 sq. feet.

The demand for outdoor space that can be utilized for demonstration work and for the display of derricks, rigs, and all types of heavy machinery, has



Leo Ranney

Leo Ranney, whose article "The World's Largest Water Well" begins on page 35 of this issue of *The Petroleum Engineer*, is president and chief engineer of the Ranney Oil Mining Company, New York City. Born at New Hartford, Iowa, August 26, 1884, Ranney graduated from New Hartford High School in 1902, from Iowa State Teachers College in 1905, and from Northwestern University in 1911. He is the inventor of processes for mining oil from depleted fields, for commercial recovery of natural gas (firedamp) from coal seams, for producing ground water, and for the formation of underground gas reservoirs, to mention but a few of his accomplishments. He is at present residing at McConnelsville, Ohio.

"If I were an ADVERTISING MANAGER"•

That's just one of the talks to be delivered anonymously by a masked speaker that will set every man thinking at the Annual Conference of National Industrial Advertisers Association in Cleveland, September 21-23. A second masked speaker will tell what he would do if he were a publication representative.

We're not going to tell you much here—just highlight the program enough to make your mouth water and your brain tingle.

T. M. Girdler, Chairman, Republic Steel Corporation, is scheduled for the opening address and when "T. M." talks he says something.

J. H. McGraw, Jr. will talk on "What I Would Do *Now* If I Were An Industrial Advertising Manager."

The new Publisher's Statement will receive full discussion.

Clinic sessions, so popular last year, will again cover a wide range of interesting subjects. Two half-day sessions instead of one.

A general conference session will cover such subjects as "Preparing the Plan", "How to Gather Usable Material", "Copy Technique", "How to Sell Management", "Co-ordinating Sales and Advertising" and "How and Why to Use an Industrial Agency."

Another session will deal with "Problems of the Small Advertiser", "Production Problems", "Public Relations"—and there are many others.

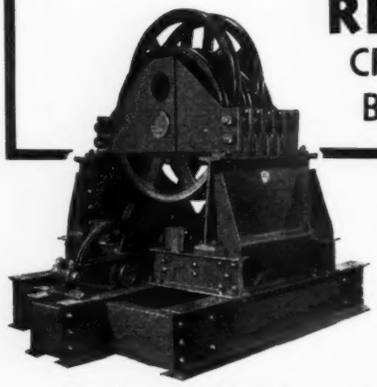
If I were an Advertising Manager, I certainly would start now to make plans to attend the 16th N. I. A. A. Conference even if I had to hitch-hike to Cleveland. And I would send in my advance registration now to—Ed. Bossart, Bailey Meter Company, Ivanhoe Road, Cleveland, Ohio.

IF I EMPLOYED AN ADVERTISING MANAGER—I would make certain that he attended this Conference, because changing times and markets demand a changed viewpoint—a new viewpoint that can be obtained only by hearing discussions by men whose experience is up-to-the-minute—right up to September 21st.

NATIONAL INDUSTRIAL ADVERTISERS ASSOCIATION

100 EAST OHIO STREET • CHICAGO, ILLINOIS

7-8-9-SHEAVE
REGAN
CROWN
BLOCK



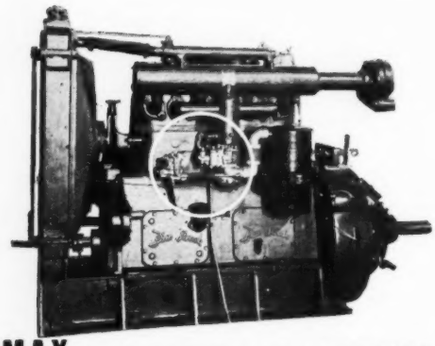
TYPE EA
300-360
TONS

Extra-heavy double-deck construction for deep drilling. The sheave beams supporting the bearings are built up of rolled steel plates welded together and surfaced on both sides to a true plane. Regan staggered bearings of massive proportions are embodied. Catline attachment or sand sheave attachment optional. Ask for Bulletin or see Composite Catalog.

Regan
Forge & Engineering Co.
Plant and General Offices
San Pedro, Cal.
P. O. Box 150

Mid-Continent Office—1502 Maury St., Houston
Oklahoma Representative—Bovaird Supply Co., Tulsa
Kansas Representative—Bovaird Supply Co., Wichita
New York City Office—17 Battery. G. R. Woods, Representative

LEADING ENGINE BUILDERS CHOOSE ENSIGN



CLIMAX Blue Streak Engine equipped with ENSIGN Combination Gas and Gasoline Carburetor.

Climax Engines for Oil Field Service are famous for ruggedness of design, accessibility and dependability. Climax, like more than ninety per cent of the leading engine manufacturers, standardizes on ENSIGN Carburetor Equipment

ENSIGN CARBURETOR CO., LTD.

Frick-Reid Moves Headquarters to Tulsa; Personnel Changes

J. L. SHAKELY

ROBERT McCOY, JR.

WM. M. PATTERSON

W. H. WEIS

H. W. WILSON

R. T. FRICK

Frick-Reid Supply Corporation, the oil-country subsidiary of the Jones and Laughlin Steel Corporation, recently announced the removal of its executive office from Pittsburgh, Pennsylvania, to Tulsa, Oklahoma, and also advised of several changes in executive personnel.

J. L. Shakely, who has been vice-president in charge of the western division of the corporation for the last several years, now heads the organization as president and will maintain headquarters in Tulsa.

Robert McCoy, jr., formerly sales manager of the western division, has been made vice-president and will also make his headquarters at Tulsa.

William M. Patterson retires from the presidency to become vice-president in charge of the corporation's eastern division having headquarters at Pittsburgh.

W. H. Weis, formerly auditor, has been made secretary and treasurer and has been moved from Pittsburgh to Tulsa.

H. H. Wilson, former assistant sales manager in the western division, has been promoted to sales manager and will have his headquarters at Tulsa.

R. T. Frick has been made district sales manager for western Pennsylvania, West Virginia, and Ohio.

Moving of the executive offices to Tulsa will result in certain operating economies and will bring the operating heads closer to the major areas being served by the corporation in the southwestern oil fields, it is pointed out.

Patents Pending on Gasoline Process

The Fluor Corporation, Los Angeles, California, has patents pending on the flow process shown in the diagram on page 70 of the Midyear issue of *The Petroleum Engineer*, illustrating an article by Joe Miller, assistant superintendent, natural gas and gasoline department, Humble Oil and Refining Company, entitled "Present-Day Trends in Design and Construction of Natural Gasoline Plants."

Here...

Oakite Cleaning

SPEEDED

muck removal

Here, according to one large company, is how the job is done . . .

All muck-covered drilling equipment is first given an application of the Oakite solution by a simple, portable spray. Then, after the solution has had a chance to soak for fifteen minutes, the equipment is hosed off. A quick final application of the Oakite solution, followed by a final hose-off leaves surfaces absolutely clean.

Full information on this new time-and-labor-saving Oakite cleaning method is yours for the asking. Write . . . there is no obligation.

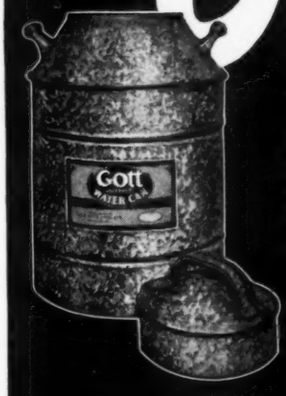
Manufactured only by
OAKITE PRODUCTS, INC., 48 Thames Street, NEW YORK, N. Y.
Branch Offices and Representatives in all Principal Cities of the U. S.

OAKITE *Certified* CLEANING

MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

Gotkool

WATER CANS & COOLERS



GOTT WATER CAN
Made in 1½, 3, 5, and 10 gallon sizes.

GOTT Water Cans are the practical way to keep drinking water cool for long periods, protected from impurities and always handy to the job. Snug fitting large removable top, strongly built to withstand rough usage. GOTT Water Coolers have extra large covers and a handy non-leaking push button faucet. Your Supply Store has them, get one today! . . . . .

GOTT WATER COOLER
Made in 3, 5, 8, 10 and 20 gallon sizes

H. P. GOTT MFG. CO.
WINFIELD, KANSAS

KEEP PURE DRINKING WATER ALWAYS HANDY

COMFORT AND CONVENIENCE!

Now you may combine the advantages of a luxurious hotel with the convenience of living economically in the very heart of the city.

Air-Conditioned

Rooms, Apartments, Suites . . .
Coffee Shop and Meeting Rooms.

That Friendly Atmosphere!

Hotel Tulsa

SPECIAL LOOSELEAF BINDER

For subscribers to THE PETROLEUM ENGINEER who find it convenient to file portions of the magazine for ready reference, we have had manufactured a special three-ring binder. It is a standard size, durable leatheroid binder with dividers for each division of the industry. The binder may be had for $1.25, express paid, by filling in the attached coupon and mailing it to us with your remittance.

THE PETROLEUM ENGINEER,
P. O. Box 1589, Dallas, Texas.

Here's my check for $1.25 for a Special Binder.

Name _____

Company _____ *Title* _____

Street _____

City _____ *State* _____

Check your division:
☐ Natural Gasoline ☐ Producing ☐ Supply ☐ Refining ☐ Manufacturing

It's no mystery

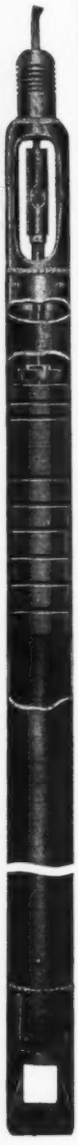
WHY THE

MILLER SAND PUMP

***increases* PRODUCTION**

The sand and sediment that decreases production, the MILLER cleans out quicker at less cost—that's why the MILLER Sand Pump is in world-wide use today!

The MILLER is made in diameters of 2½, 3, 3½, 4, 4¼, 5, 5½, 7 and 9 inches and lengths of 20, 25 and 30 feet, 5/32-inch wall thickness in REGULAR TYPE, ¼-inch wall tubes HEAVY Type Sand Pumps.



INTERCHANGEABLE BOTTOMS

To Meet Every Condition

- **BAILER BOTTOM**

  With the Bailer Bottom installed the MILLER is quickly changed to a Bailer giving you a combination of either Bailer or a Sand Pump in one tool.

- **SAND BOTTOM**

  Used when tools are run and when well is shot to quickly remove loose material.

- **STAR BOTTOM**

  Used for cutting the sand loose.

- **CHISEL BOTTOM**

  (In Pump)

  With this bottom tightly packed sand can be easily broken in small pieces so it can be picked up in the pump.

Write for Descriptive Folder and Price List

See Page 1445 COMPOSITE CATALOG

MILLER

Sand Pump Co.

PATENTED NO. 1379260 NO. 1523506 NO. 1787986 NO. 1843660 NO. 1896466 NO. 2018667

General Offices and Shop, Box 4516

OKLAHOMA CITY, OKLA., U. S. A.

Branch Shops and Offices:

SAPULPA, OKLA. and KILGORE, TEX.

FOR SALE BY SUPPLY STORES EVERYWHERE

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THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 15

IN publishing this series of tables THE PETROLEUM ENGINEER is endeavoring to meet the diverse needs of a large number of readers employed in all branches of the oil industry. At present the number of tables published for each division reflects as well as can be determined the relative demand for material applicable to that division. Comments and suggestions from readers are cordially invited, for the more of these that are received the more closely will the editors be able to gauge the readers' interest.

Engineering Data Especially Compiled for Office, Field, and Plant Use

A REGULAR FEATURE OF THE PETROLEUM ENGINEER

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A.P.I. DIMENSIONAL STANDARDS FOR CABLE DRILLING TOOL JOINTS, ROPE SOCKET NECKS, AND JARS

Size of taper joint, in.	Length of taper pin, in.	Size of wrench square, in.	Part of joint	Collar diam., in.	Length of collar, in.				Rope socket neck diam., in.		Jar dimensions, in.				
					Fishing tools and subs[1]	Stem[1]	Jars	Bits[1]	Manila[2] cable	Wire rope	Diam. over reins	Short stroke[3]		General utility stroke[3]	Fishing jars, stroke[3]
												Next to bit	Regular drilling		
1 x1½	2	1½	Pin	2	2½	2½	2½— 5	5	.....	1¼	2 1/16	.....	.....	10	24
			Box	2 1/16	3½	3½	3½— 5	....							
1⅛x1¾[a]	2½	1¾	Pin	2½	3	3	3 — 5½	5½	.....	2	2½	.....	.....	10	24
			Box	2⅝	5	5	5 — 6	....							
1½x2¼	3	2¼	Pin	3⅛	3½	3½	3½— 6	6	.....	2	3¼	.....	.....	10	24
			Box	3¼	6	6	6 — 7	....							
1⅝x2⅝	3½	2¾	Pin	3⅝	4	4	4 — 7	7	2¾	2½	3⅝	.....	4½	10	24, 30
			Box	3¾	6	7	6 — 8	....							
2 x3	4	3¼	Pin	4¼	4½	5	4½— 7½	7½	3¼	2¾	4⅜	3½	4½	10	24, 30, 36
			Box	4⅜	7	9	7 — 9	....							
2¼x3¼	4	3½	Pin	4½	4½	5½	4½— 8	8	3¼	3¼	4¾	3½	4½	10	30, 36
			Box	4¾	7	9½	7 — 9½	....							
2½x3½	4¼	4	Pin	5	5	6	5 — 8½	8½	3½	3½	5¼	3½	4½	10	30, 36
			Box	5¼	7	10	7 —10	....							
2¾x3¾	4½	4[b]	Pin	5¼[c]	5	6	5 — 8½	8½	3½	3½	5½	3½	4½	10	36, 48, 60
			Box	5½	8	11	8 —11	....							
3 x4	4¾	4½	Pin	6	5½	6½	5½— 9	9	4	4	6¼	3½	4½	10	36, 48, 60
			Box	6¼	8	11	8 —11	....							
3¼x4¼	5	5	Pin	6¼	6	7	6 —10	10	4½	4½	6½	3½	4½	10	36, 48, 60
			Box	6½	9	12	9 —12	....							
3½x4½	5½	5	Pin	6½	6	7	6 —10	10	4½	4½	6½	3½	4½	10	36, 48, 60
			Box	6¾	9	12	9 —12	....							
4 x5	5½	5, 5½	Pin	7	6½	7½	6½—11	11	4½	4½	7	3½	5	10	36, 48, 60
			Box	7⅜	10	12	10 —12	....							
4 x5½	6½	5½	Pin	7½	6½	7½	6½—11	11	5½	5½	7½	3½	5	10	36, 48, 60
			Box	7⅞	10	12	10 —12	....							
4¼x6	7	6	Pin	8¼	7	8	7 —12	12	5½	5½	8¼	3½	5	10	36, 48, 60
			Box	8⅝	10	13	10 —13	....							

All cable drilling tool joints taper 3 in. per ft. and are threaded U. S. Standard 8 threads per in. on 1½ x 2¼ and smaller, and 7 threads per in. on 1⅝ x 2⅝ and larger.

[1]Length of collar shown is minimum. Longer collars may be used.

[2]In fields where jars are not used, manila rope sockets are sometimes left larger than the A. P. I. standard to permit the use of a bumper without damaging the neck.

[3]Jars are made regularly in 3½-in., 4½-in., 6-in., 8-in., 10-in., 24-in., 36-in., 48-in., 60-in., and 72-in. strokes by most manufacturers. Other strokes may be supplied on special order. Operating conditions determine the stroke desired.

[a]Standard size for all rope cutting tools.

[b]In Ohio and Michigan most operators use 4¼-in. squares on 2¾ x 3¾-in. joints. (Not an A. P. I. standard.)

[c]Where 2¾ x 3¾-in. pins are used in a big hole (8 in. or larger) some operators prefer to use 5-in. squares and 6¼-in. or 6½-in. chamfered collars to prevent rapid wear on jars by holding them away from the wall. (Not an A. P. I. standard.)

SPECIFY

SPANG

The HIGHER STANDARD

THE *Complete* LINE OF CABLE-SYSTEM DRILLING AND FISHING TOOLS

Fig. 511 SPANG Weldless Jars

Fig. 524 SPANG Twisted Bit

Fig. 526 SPANG Straight Bit

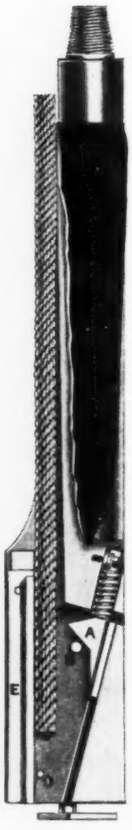


Fig. 671 Eclipse Wire Rope Knife

On this page is reproduced only a small portion of the *complete* line of SPANG "Higher-Standard" Cable Tools.

SPANG Tools are *better* tools, because they are built by men who know the precise requirements of cable-system drilling. And behind them lies full knowledge of the properties of high-grade steels necessary for efficient heavy-duty drilling. Costs are lower, delays are fewer, drilling results are more satisfactory where these better tools are used.

A cable string can be only as strong as its weakest tool. "Misfit tools" may cost you time and money. So, SPECIFY SPANG for the entire string.

Fig. 505 Prosser Swivel Rope Socket

Fig. 611 SPANG Collar Socket

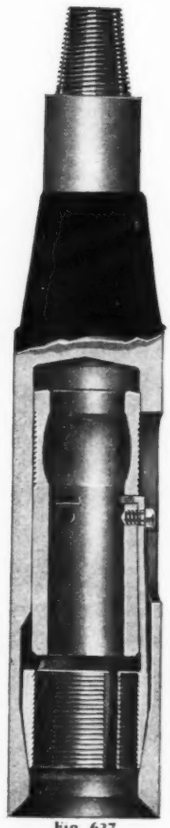


Fig. 627 SPANG Full-Circle Slip Socket

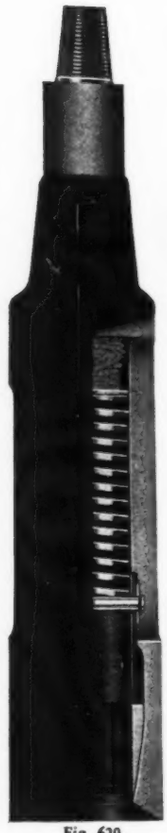


Fig. 620 SPANG Combination Socket

Fig. 516 Stem Pin (Heat-Treated)

Fig. 517 Stem Box (Heat-Treated)

Plus—A Complete Line of

SPANG *"Higher-Standard"* PACKERS

SPANG & COMPANY, BUTLER, PA.

PRESSURE DROP, LB. PER SQ. IN. PER MILE OF 10-IN.[1] PIPE LINE (OIL OF 30° A.P.I.)

Quantity of 30° A.P.I. oil, bbl. per hr.	Viscosity of oil, Saybolt Universal seconds										
	100	110	120	130	140	150	160	180	200	220	240
650	4.77	4.92	5.05	5.16	5.28	5.38	5.48	5.66	5.83	5.98	6.13
675	5.10	5.26	5.39	5.52	5.63	5.75	5.86	6.05	6.22	6.38	6.54
700	5.44	5.60	5.75	5.88	6.00	6.13	6.24	6.45	6.63	6.80	6.97
725	5.79	5.95	6.11	6.25	6.38	6.51	6.64	6.85	7.05	7.23	7.41
750	6.14	6.31	6.48	6.63	6.77	6.90	7.04	7.27	7.48	7.67	7.85
775	6.49	6.68	6.85	7.01	7.17	7.30	7.44	7.69	7.91	8.11	8.31
800	6.85	7.06	7.24	7.41	7.57	7.72	7.86	8.13	8.36	8.58	8.78
825	7.22	7.45	7.64	7.82	7.99	8.15	8.29	8.58	8.82	9.05	9.26
850	7.60	7.85	8.06	8.24	8.42	8.59	8.74	9.03	9.29	9.54	9.76
875	7.99	8.25	8.48	8.66	8.85	9.03	9.19	9.50	9.78	10.03	10.26
900	8.39	8.65	8.89	9.10	9.29	9.48	9.65	9.96	10.27	10.54	10.78
925	8.80	9.06	9.33	9.55	9.74	9.93	10.12	10.45	10.77	11.05	11.31
950	9.21	9.49	9.76	10.00	10.20	10.41	10.60	10.95	11.28	11.57	11.85
975	9.63	9.92	10.21	10.46	10.68	10.88	11.09	11.46	11.80	12.12	12.40
1000	10.06	10.37	10.66	10.93	11.17	11.37	11.59	11.98	12.33	12.66	12.96
1025	10.50	10.83	11.12	11.41	11.66	11.88	12.10	12.51	12.86	13.22	13.52
1050	10.95	11.28	11.58	11.88	12.15	12.38	12.61	13.03	13.40	13.77	14.10
1075	11.41	11.75	12.06	12.37	12.66	12.91	13.14	13.57	13.97	14.34	14.69
1100	11.88	12.23	12.56	12.87	13.18	13.44	13.68	14.13	14.55	14.93	15.30
1125	12.34	12.72	13.06	13.38	13.69	13.97	14.22	14.70	15.12	15.52	15.91
1150	12.81	13.22	13.57	13.89	14.22	14.53	14.79	15.28	15.72	16.13	16.52
1175	13.29	13.70	14.07	14.41	14.74	15.06	15.34	15.85	16.31	16.74	17.13
1200	13.78	14.21	14.60	14.95	15.30	15.63	15.92	16.43	16.91	17.36	17.78
1225	14.28	14.73	15.11	15.49	15.84	16.19	16.49	17.03	17.53	17.99	18.41
1250	14.78	15.25	15.67	16.05	16.39	16.76	17.09	17.64	18.16	18.65	19.07
1275	15.29	15.78	16.23	16.61	16.97	17.33	17.69	18.27	18.81	19.30	19.75
1300	15.82	16.31	16.78	17.17	17.57	17.92	18.28	18.90	19.44	19.95	20.44
1325	16.35	16.84	17.33	17.74	18.14	18.52	18.89	19.53	20.09	20.62	21.11
1350	16.90	17.40	17.89	18.33	18.74	19.12	19.51	20.17	20.76	21.31	21.81
1375	17.44	17.97	18.47	18.93	19.33	19.73	20.13	20.84	21.43	22.00	22.52
1400	18.00	18.54	19.07	19.52	19.96	20.37	20.76	21.52	22.11	22.70	23.24
1425	18.58	19.12	19.64	20.14	20.57	21.02	21.40	22.19	22.82	23.41	23.97
1450	19.16	19.70	20.23	20.75	21.19	21.64	22.03	22.85	23.50	24.11	24.69
1475	19.73	20.29	20.84	21.38	21.83	22.29	22.70	23.53	24.23	24.85	25.43
1500	20.33	20.88	21.46	22.01	22.48	22.93	23.38	24.21	24.96	25.58	26.21
1525	20.92	21.48	22.08	22.65	23.14	23.60	24.07	24.89	25.67	26.34	26.96
1550	21.53	22.12	22.70	23.26	23.80	24.28	24.76	25.61	26.41	27.11	27.75
1575	22.12	22.76	23.33	23.91	24.46	24.96	25.43	26.31	27.16	27.88	28.54
1600	22.74	23.39	23.99	24.55	25.12	25.66	26.12	27.03	27.91	28.65	29.30
1625	23.34	24.04	24.63	25.21	25.83	26.36	26.83	27.76	28.67	29.43	30.11
1650	23.97	24.70	25.30	25.91	26.51	27.05	27.54	28.51	29.41	30.23	30.92
1675	24.61	25.36	25.98	26.57	27.20	27.76	28.26	29.28	30.19	31.03	31.75
1700	25.26	26.03	26.67	27.25	27.89	28.50	29.01	30.04	30.97	31.84	32.57
1725	25.86	26.66	27.35	27.95	28.57	29.20	29.76	30.79	31.74	32.64	33.40
1750	26.52	27.34	28.05	28.66	29.31	29.95	30.50	31.58	32.54	33.45	34.24
1775	27.18	28.02	28.75	29.38	30.05	30.71	31.27	32.36	33.34	34.28	35.12
1800	27.85	28.71	29.46	30.11	30.76	31.44	32.05	33.13	34.14	35.11	35.98
1825	28.52	29.40	30.18	30.85	31.51	32.18	32.84	33.95	34.95	35.99	36.87
1850	29.19	30.10	30.94	31.58	32.27	32.95	33.60	34.74	35.80	36.83	37.74
1875	29.86	30.79	31.65	32.36	33.02	33.68	34.38	35.56	36.65	37.66	38.64
1900	30.54	31.50	32.38	33.11	33.79	34.47	35.15	36.39	37.51	38.52	39.56
1925	31.23	32.22	33.12	33.86	34.56	35.26	35.96	37.23	38.35	39.42	40.44
1950	31.92	32.93	33.86	34.66	35.34	36.06	36.78	38.08	39.22	40.28	41.38
1975	32.66	33.70	34.61	35.43	36.12	36.86	37.60	38.94	40.11	41.19	42.28
2000	33.36	34.43	35.40	36.25	36.96	37.67	38.42	39.80	41.00	42.07	43.18
2025	34.05	35.15	36.15	37.01	37.74	38.51	39.24	40.65	41.84	42.98	44.11
2050	34.76	35.93	36.91	37.84	38.59	39.33	40.08	41.53	42.74	43.91	45.03
2075	35.47	36.67	37.72	38.63	39.44	40.16	40.92	42.41	43.65	44.84	45.94
2100	36.24	37.41	38.49	39.42	40.25	40.99	41.77	43.29	44.56	45.79	46.91
2125	37.01	38.21	39.26	40.27	41.12	41.87	42.62	44.18	45.48	46.74	47.89
2150	37.72	38.95	40.08	41.05	41.98	42.70	43.52	45.06	46.44	47.73	48.86
2175	38.50	39.76	40.86	41.91	42.80	43.59	44.38	45.96	47.37	48.69	49.84
2200	39.23	40.52	41.65	42.72	43.69	44.50	45.30	46.86	48.31	49.65	50.84
2225	40.02	41.34	42.49	43.54	44 53	45.41	46.18	47.77	49.25	50.63	51.84
2250	40.76	42.11	43.34	44.41	45.42	46.32	47.11	48.68	50.26	51.61	52.90

[1]32.75 lb. per ft. For 35.75 lb. line pipe the pressure drop is about 2.6% greater and for 41.85 lb. line pipe it is about 8.4% greater.

PREST-O-LITE ACETYLENE

is convenient for use in all

OXY-ACETYLENE PROCESS APPLICATIONS

Prest-O-Lite dissolved acetylene — made from Union Carbide—is especially convenient for all oxy-acetylene process applications that do not justify the installation of an acetylene generator. Obtainable from hundreds of stock points throughout the country, Prest-O-Lite acetylene is always available for instant use with any make or type of oxy-acetylene equipment.

The same sales and service organization that is back of Prest-O-Lite dissolved acetylene also is prepared to supply you with Linde oxygen, Oxweld apparatus and supplies, and Union Carbide. Thus, no matter what your interest in the oxy-acetylene process may be—whether in production, repair or new construction—you can coordinate your requirements for materials and service through Linde.

The Linde sales, engineering, and service facilities can assist you in welding, cutting, flame hardening, flame softening, hardfacing or in any other application of the oxy-acetylene process peculiar to your business. Write to The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, New York and principal cities.

The words "Linde," "Prest-O-Lite," "Oxweld" and "Union" used herein are registered trade-marks.

Full Before They are Filled!

Few products require a container comparable to a Prest-O-Lite acetylene cylinder. Before it receives acetylene, each cylinder must be tested and filled with a porous material saturated with acetone, a liquid capable of absorbing many times its own volume of acetylene. In service, an exact life record must be maintained for each cylinder, and frequent and rigid inspections continued.

Everything for Oxy-Acetylene Welding and Cutting

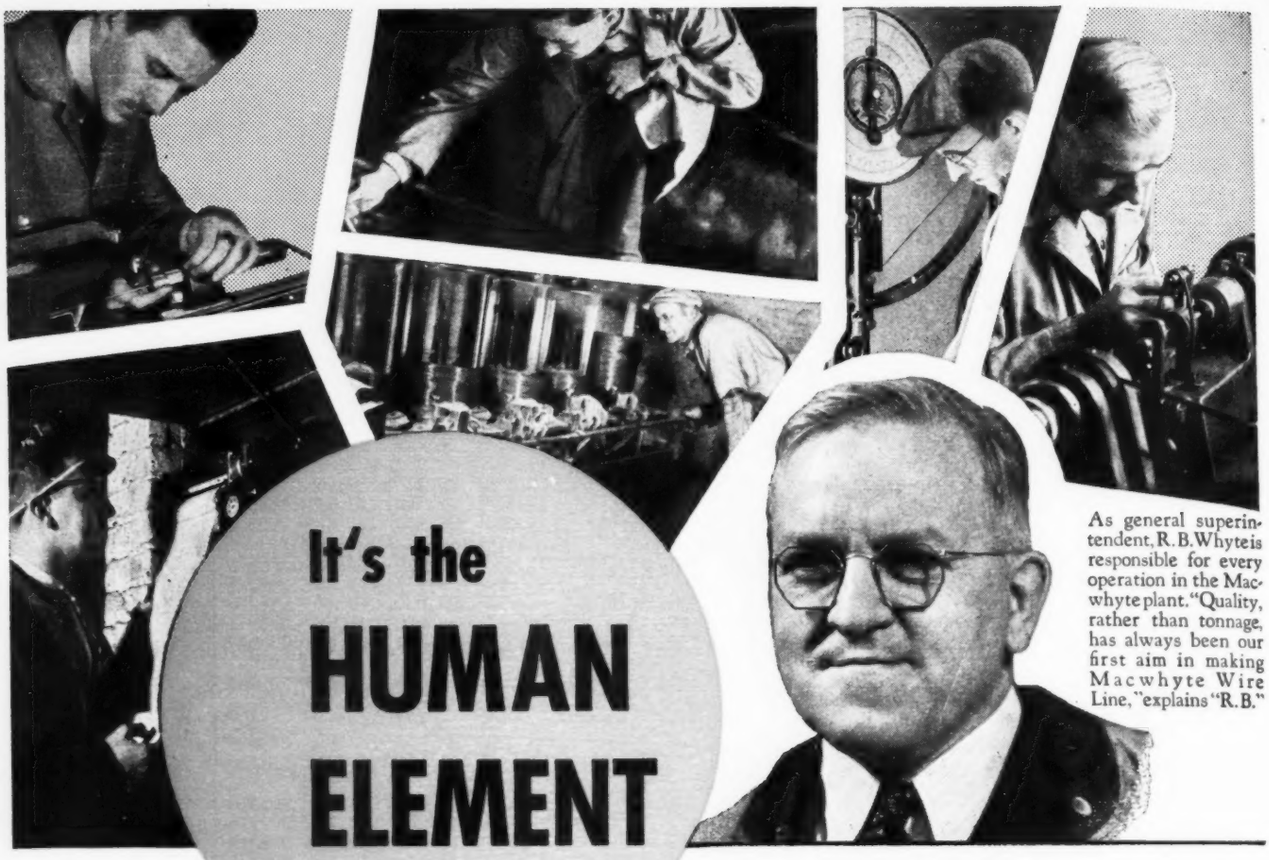
FROM LINDE

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES • UNION CARBIDE

WEIGHT AND VOLUME OF 6⅝-IN. DRILL PIPE

Length of string of drill pipe, ft.	22.2 lb. drill pipe				25.2 lb. drill pipe				31.9 lb. drill pipe			
	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.
2,000	44,400	678.4	6,445	37,955	50,400	770.2	7,315	43,085	63,800	975.0	9,260	54,540
2,200	48,840	746.2	7,090	41,750	55,440	847.2	8,050	47,390	70,180	1072.5	10,190	59,990
2,400	53,280	814.1	7,735	45,545	60,480	924.2	8,780	51,700	76,560	1170.0	11,115	65,445
2,600	57,720	881.9	8,380	49,340	65,520	1001.3	9,510	56,010	82,940	1267.5	12,040	70,900
2,800	62,160	949.8	9,025	53,135	70,560	1078.3	10,245	60,315	89,320	1365.0	12,970	76,350
3,000	66,600	1017.6	9,665	56,935	75,600	1155.3	10,975	64,625	95,700	1462.5	13,895	81,805
3,200	71,040	1085.4	10,310	60,730	80,640	1232.3	11,705	68,9 5	102,080	1560.0	14,820	87,260
3,400	75,480	1153.3	10,955	64,525	85,680	1309.3	12,440	73,240	108,460	1657.5	15,745	92,715
3,600	79,920	1221.1	11,600	68,320	90,720	1386.4	13,170	77,550	114,840	1755.0	16,670	98,170
3,800	84,360	1289.0	12,245	72,115	95,760	1463.4	13,900	81,860	121,220	1852.5	17,600	103,620
4,000	88,800	1356.8	12,890	75,910	100,800	1540.4	14,635	86,165	127,600	1950.0	18,525	109,075
4,200	93,240	1424.6	13,535	79,705	105,840	1617.4	15,365	90,475	133,980	2047.5	19,450	114,530
4,400	97,680	1492.5	14,180	83,500	110,880	1694.4	16,095	94,785	140,360	2145.0	20,380	119 980
4,600	102,120	1560.3	14,825	87,295	115,920	1771.5	16,830	99,090	146,740	2242.5	21,305	125,435
4,800	106,560	1628.2	15,470	91,090	120,960	1848.5	17,560	103,400	153,120	2340.0	22,230	130,890
5,000	111,000	1696.0	16,110	94,890	126,000	1925.5	18,290	107,710	159,500	2437.5	23,155	136,345
5,200	115,440	1763.8	16,755	98,685	131,040	2002.5	19,025	112,015	165,880	2535.0	24,080	141,800
5,400	119,880	1831.7	17,400	102,480	136,080	2079.5	19,755	116,325	172,260	2632.5	25,010	147,250
5,600	124,320	1899.5	18,045	106,275	141,120	2156.6	20,485	120,635	178,640	2730.0	25,935	152,705
5,800	128,760	1967.4	18,690	110,070	146,160	2233.6	21,220	124,940	185,020	2827.5	26,860	158,160
6,000	133,200	2035.2	19,335	113,865	151,200	2310.6	21,950	129,250	191,400	2925.0	27,790	163,610
6,200	137,640	2103.0	19,980	117,660	156,240	2387.6	22,680	133,560	197,780	3022.5	28,715	169,065
6,400	142,080	2170.9	20,625	121,455	161,280	2464.6	23,415	137,865	204,160	3120.0	29,640	174,520
6,600	146,520	2238.7	21,270	125,250	166,320	2541.7	24,145	142,175	210,540	3217.5	30,565	179,975
6,800	150,960	2306.6	21,910	129,050	171,360	2618.7	24,875	146,485	216,920	3315.0	31,490	185,430
7,000	155,400	2374.4	22,555	132,845	176,400	2695.7	25,610	150,790	223,300	3412.5	32,420	190,880
7,200	159,840	2442.2	23,200	136,640	181,440	2772.7	26,340	155,100	229,680	3510.0	33,345	196,335
7,400	164,280	2510.1	23,845	140,435	186,480	2849.7	27,075	159,405	236,060	3607.5	34,270	201,790
7,600	168,720	2577.9	24,490	144,230	191,520	2926.8	27,805	163,715	242,440	3705.0	35,200	207,240
7,800	173,160	2645.8	25,135	148,025	196,560	3003.8	28,535	168,025	248,820	3802.5	36,125	212,695
8,000	177,600	2713.6	25,780	151,820	201,600	3080.8	29,270	172,330	255,200	3900.0	37,050	218,150
8,200	182,040	2781.4	26,425	155,615	206,640	3157.8	30,000	176,640	261,580	3997.5	37,975	223,605
8,400	186,480	2849.3	27,070	159,410	211,680	3234.8	30,730	180,950	267,960	4095.0	38,900	229,060
8,600	190,920	2917.1	27,715	163,205	216,720	3311.9	31,465	185,255	274,340	4192.5	39,830	234,510
8,800	195,360	2985.0	28,355	167,005	221,760	3388.9	32,195	189,565	280,720	4290.0	40,755	239,965
9,000	199,800	3052.8	29,000	170,800	226,800	3465.9	32,925	193,875	287.100	4387.5	41,680	245,420
9,200	204,240	3120.6	29,645	174,595	231,840	3542.9	33,660	198,180	293.480	4485.0	42,610	250,870
9,400	208,680	3188.5	30,290	178,390	236,880	3619.9	34,390	202,490	299,860	4582.5	43,535	256,325
9,600	213,120	3256.3	30,935	182,185	241,920	697.0	35,120	206,800	306,240	4680.0	44,460	261,780
9,800	217,560	3324.2	31,580	185,980	246,960	3774.0	35,855	211,105	312,620	4777.5	45,385	267,235
10,000	222,000	3392.0	32,225	189,775	252,000	3851.0	36,585	215,415	319,000	4875.0	46,310	272,690
10,200	226,440	3459.8	32,870	193,570	257,040	3928.0	37,315	219,725	325,380	4972.5	47,240	278,140
10,400	230,880	3527.7	33,515	197,365	262,080	4005.0	38,050	224,030	331,760	5070.0	48,165	283,595
10,600	235,320	3595.5	34,155	201,165	267,120	4082.1	38,780	228,340	338,140	5167.5	49,090	289,050
10,800	239,760	3663.4	34,800	204,960	272,160	4159.1	39,510	232,650	344,520	5265.0	50,020	294,500
11,000	244,200	3731.2	35,445	208,755	277,200	4236.1	40,245	236,955	350,900	5362.5	50,945	299,955
11,200	248,640	3799.0	36,090	212,550	282,240	4313.1	40,975	241 265	357,280	5460.0	51,870	305,410
11,400	253,080	3866.9	36,735	216,345	287,280	4390.1	41,705	245,575	363,660	5557.5	52,795	310,865
11,600	257,520	3 34.7	37,380	220,140	292,320	4467.2	42,440	249,880	370,040	5655.0	53,720	316,320
11,800	261,960	4002.6	38,025	223,935	297,360	4544.2	43,170	254,190	376,420	5752.5	54,650	321,770
12,000	266,400	4070.4	38,670	227,730	302,400	4621.2	43,900	258,500	382,800	5850.0	55,575	327,225
12,200	270,840	4138.2	39,315	231,525	307,440	4698.2	44,635	262,805	389,180	5947.5	56,500	332,680
12,400	275,280	4206.1	39,960	235,320	312,480	4775.2	45,365	267,115	395,560	6045.0	57,430	338,130
12,600	279,720	4273.9	40,600	239,120	317,520	4852.3	46,095	271,425	401,940	6142.5	58,355	343,585
12,800	284,160	4341.8	41,245	242,915	322,560	4929.3	46,830	275,730	408,320	6240.0	59,280	349,040
13,000	288,600	4409.6	41,890	246,710	327,600	5006.3	47,560	280,040	414,700	6337.5	60,205	354,495

[1]If a regular tool joint is inserted every 90 ft. all values for 22.2-lb. drill pipe will be increased about 4.0 percent, for 25.2-lb. drill pipe about 3.5 percent, and for 31.9-lb. drill pipe about 2.4 percent.



As general superintendent, R. B. Whyte is responsible for every operation in the Macwhyte plant. "Quality, rather than tonnage, has always been our first aim in making Macwhyte Wire Line," explains "R. B."

It's the HUMAN ELEMENT that controls the quality of Macwhyte PREformed Wire Lines

● Why do some makes of wire lines give much better, much longer, service than others?

You know most of the reasons: better materials . . . efficient manufacturing equipment . . . rigid laboratory and field tests. These are absolutely necessary in building long life into wire lines.

But *most important* in manufacturing *better* wire lines are the *men* who make it!

Men, as well as materials, control quality

"We use the finest steels, the most modern machinery," explains R. B. Whyte, General Superintendent, "but it's the 'human element' that controls the high quality you find in Macwhyte PREformed.

Quality, rather than tonnage, Macwhyte aim

"We've always based compensation on quality workmanship, never tonnage. As a result our workmen take a pride in their jobs. They've become experts in their lines. And the Macwhyte Wire Line they make is *better* wire line."

Over the years, this policy of "quality rather than tonnage" has proved sound. For today there are more users of Macwhyte PREformed and Regular Wire Lines than ever before.

These distributors will give you quick service:

EASTERN FIELDS
Baldwin Supply Company
Branchland Pipe & Supply Co.
Bradford Supply Company
H. P. Brestle & Son
Federal Oil Field Supply Co.
Franklin Tool Company
International Derrick & Equipment Co.
L. L. Morris Supply

MID-CONTINENT FIELDS
Bradford Supply Company
Carson Machine & Supply Co.
The Drillers Supply Co.
Dunigan Tool & Supply Co.
East Texas Tool & Supply Co.
El Dorado Foundry, Machine & Supply Co.
The Federal Supply & Machine Co.
International Derrick & Equipment Co.
Superior Iron Works & Supply Co., Inc.
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MOUNTAIN STATES
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Manufacturers of wire lines and braided wire rope slings.

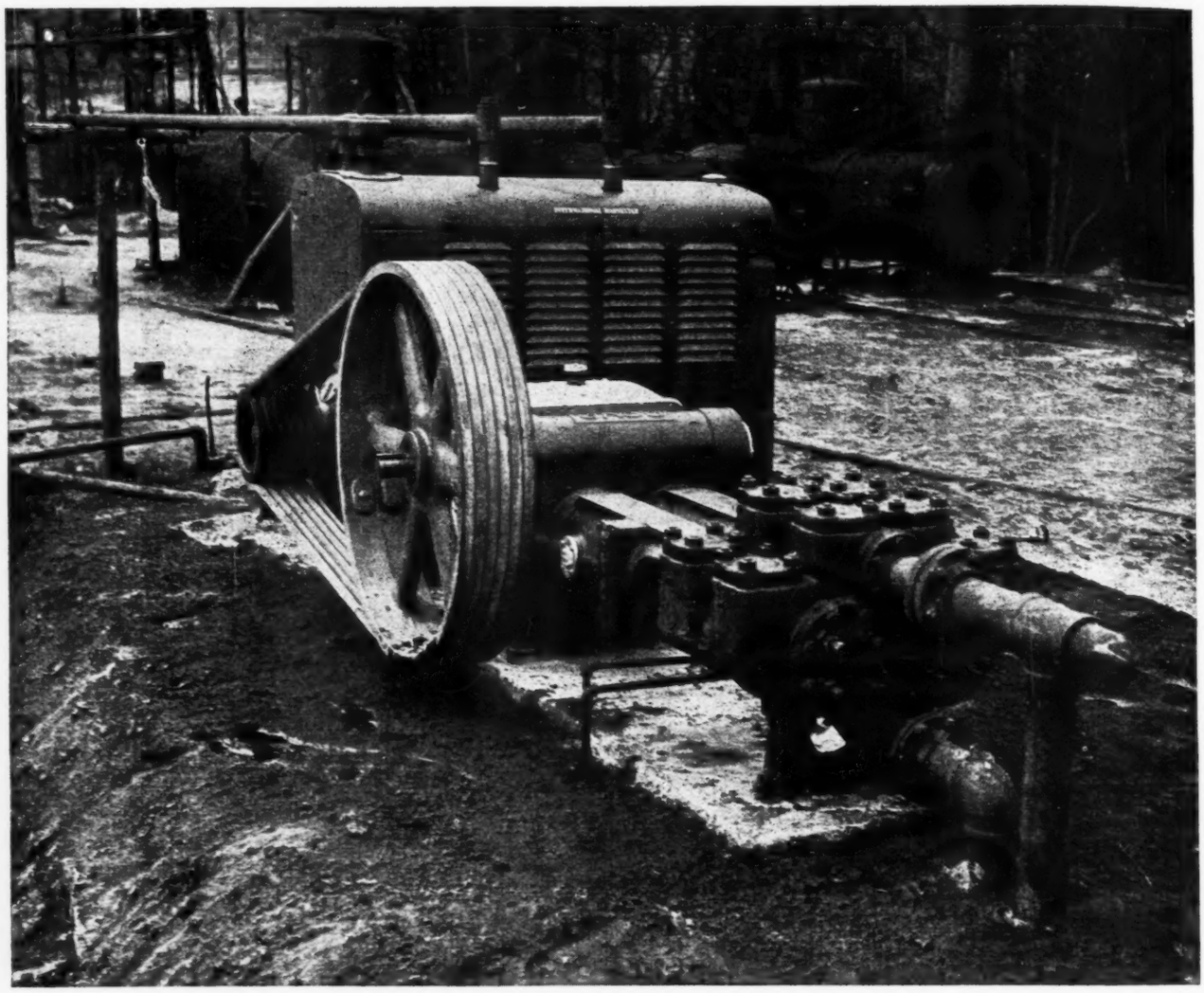
Distributors and stock throughout the oil fields for quick service

MACWHYTE
Whyte Strand - PREformed
THE ROTARY LINE WITH THE INTERNAL LUBRICATION

CAPACITY OF BOLTED STEEL TANKS, 42-GAL. BBL.

Low 500 and high 1,000 bbl. A. P. I. tanks						Low 1,000 and 2,000 bbl. A. P. I. tanks					
Ft.	In.	Gross	Net	Net less		Ft.	In.	Gross	Net	Net less	
			Gross less deadwood	2 percent	3 percent				Gross less deadwood	2 percent	3 percent
	1/16	.3381	.3380	.3312	.3279		1/16	.6435	.6433	.6304	.6240
	1/8	.6762	.6760	.6625	.6557		1/8	1.2870	1.2866	1.2608	1.2480
	3/16	1.0143	1.0140	.9937	.9836		3/16	1.9304	1.9299	1.8913	1.8720
	1/4	1.3524	1.3520	1.3250	1.3114		1/4	2.5739	2.5732	2.5217	2.4960
	5/16	1.6904	1.6900	1.6562	1.6393		5/16	3.2174	3.2164	3.1521	3.1199
	3/8	2.0285	2.0280	1.9874	1.9672		3/8	3.8609	3.8597	3.7825	3.7439
	7/16	2.3666	2.3659	2.3186	2.2949		7/16	4.5043	4.5030	4.4130	4.3679
	1/2	2.7047	2.7039	2.6498	2.6228		1/2	5.1478	5.1463	5.0434	4.9919
	9/16	3.0428	3.0419	2.9811	2.9506		9/16	5.7913	5.7896	5.6738	5.6159
	5/8	3.3809	3.3799	3.3123	3.2785		5/8	6.4348	6.4329	6.3042	6.2399
	11/16	3.7190	3.7179	3.6435	3.6064		11/16	7.0783	7.0762	6.9346	6.8639
	3/4	4.0571	4.0559	3.9748	3.9342		3/4	7.7217	7.7195	7.5651	7.4879
	13/16	4.3951	4.3939	4.3060	4.2621		13/16	8.3652	8.3627	8.1955	8.1119
	7/8	4.7332	4.7319	4.6373	4.5899		7/8	9.0087	9.0060	8.8259	8.7359
	15/16	5.0713	5.0699	4.9685	4.9178		15/16	9.6522	9.6493	9.4563	9.3598
	1	5.4094	5.4079	5.2997	5.2457		1	10.2956	10.2926	10.0868	9.9838
	2	10.8188	10.8158	10.5995	10.4913		2	20.5913	20.5852	20.1735	19.9677
	3	16.2282	16.2237	15.8992	15.7370		3	30.8869	30.8778	30.2603	29.9515
	4	21.6376	21.6315	21.1989	20.9826		4	41.1825	41.1704	40.3470	39.9353
	5	27.0470	27.0394	26.4986	26.2282		5	51.4782	51.4630	50.4338	49.9192
	6	32.4564	32.4473	31.7984	31.4739		6	61.7738	61.7557	60.5205	59.9030
	7	37.8659	37.8552	37.0981	36.7195		7	72.0695	72.0483	70.6073	69.8868
	8	43.2753	43.2631	42.3978	41.9652		8	82.3651	82.3409	80.6941	79.8706
	9	48.6847	48.6710	47.6976	47.2109		9	92.6607	92.6335	90.7808	89.8545
	10	54.0941	54.0788	52.9972	52.4564		10	102.9564	102.9261	100.8676	99.8383
	11	59.5035	59.4867	58.2970	57.7021		11	113.2520	113.2187	110.9543	109.8221
1		64.9129	64.8946	63.5967	62.9478	1		123.5476	123.5113	121.0411	119.8060
2		129.8258	129.7892	127.1934	125.8955	2		247.0953	247.0226	242.0822	239.6119
3		194.7387	194.6838	190.7901	188.8433	3		370.6429	370.5339	363.1232	359.4179
4		259.6516	259.5784	254.3868	251.7910	4		494.1906	494.0452	484.1643	479.2239
5		324.5645	324.4730	317.9835	314.7388	5		617.7382	617.5565	605.2054	599.0298
6		389.4774	389.3676	381.5802	377.6866	6		741.2858	741.0678	726.2465	718.8358
7		454.3903	454.2623	445.1771	440.6344	7		864.8335	864.5791	847.2875	838.6418
8		519.3032	519.1569	508.7738	503.5822	8		988.3811	988.0904	968.3286	958.4477
9		584.2161	584.0515	572.3705	566.5300	9		1111.9288	1111.6017	1089.3697	1078.2537
10		649.1290	648.9461	635.9672	629.4777	10		1235.4764	1235.1130	1210.4108	1198.0597
11		714.0419	713.8407	699.5639	692.4255	11		1359.0240	1358.6243	1331.4519	1317.8656
12		778.9548	778.7353	763.1606	755.3732	12		1482.5717	1482.1357	1452.4929	1437.6716
13		843.8676	843.6299	826.7573	818.3210	13		1606.1193	1605.6470	1573.5340	1557.4775
14		908.7805	908.5245	890.3540	881.2688	14		1729.6670	1729.1583	1694.5751	1677.2835
15		973.6934	973.4191	953.9507	944.2165	15		1853.2146	1852.6696	1815.6162	1797.0895
16		1038.6063	1038.3137	1017.5474	1007.1643	16		1976.7622	1976.1809	1936.6572	1916.8954

Let International Power Units *Cut Your Power Costs*



Above: Oil from 90 wells is gathered in stock tanks at the location shown here and then pumped a distance of 12 miles at the rate of 240 barrels an hour by this International PA-100 Power Unit which powers a 5 x 10 pump, 50 strokes a minute, 400 pounds pressure. This International replaced the steam plant, shown in the background, last year. With steam, another booster was required to pump the oil the last three miles. P. H. Pewitt, owner of this International in the East Texas field, is now installing 15 International P-30 Power Units to provide power for wells going on the pump.

The power of International Harvester Engines is available to the oil industry in gasoline, gas, and Diesel power units ranging up to 110 max. h.p. These units are used singly or in batteries to provide power for a surprising variety of jobs. These engines are giving maximum performance for every power dollar invested. Look to International Engines to cut your power costs. Ask the nearby International dealer or Company-owned branch for complete information. Also investigate International Trac-TracTors (crawlers) and Wheel Tractors for mobile power work.

INTERNATIONAL HARVESTER COMPANY

(Incorporated)

180 North Michigan Avenue — Chicago, Illinois

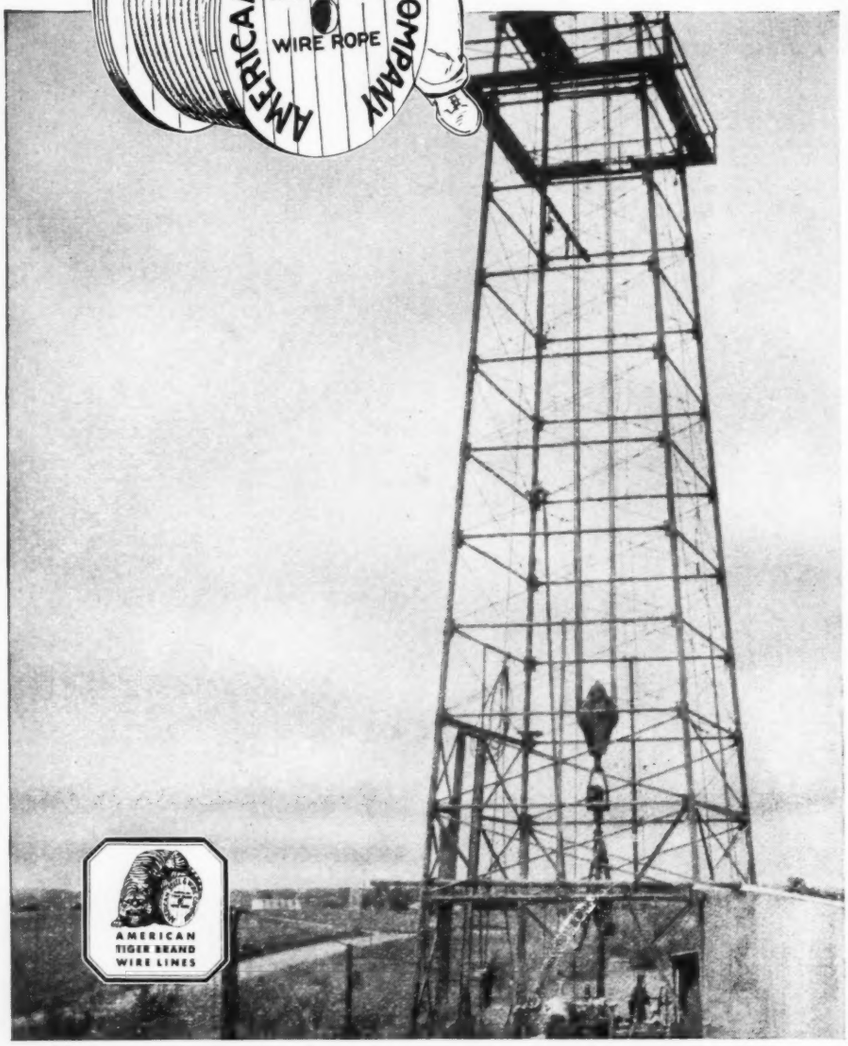
INTERNATIONAL Industrial Power

WEIGHT AND VOLUME OF 7⅝-IN. AND 8⅝-IN. DRILL PIPE

Length of string of drill pipe, ft.	7⅝-in. drill pipe (29.25 lb. per ft.)				8⅝-in. drill pipe (40.00 lb. per ft.)			
	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.
2,000	58,500	894.0	8,495	50,005	80,000	1222.4	11,615	68,385
2,200	64,350	983.4	9,340	55,010	88,000	1344.6	12,775	75,225
2,400	70,200	1072.8	10,190	60,010	96,000	1466.9	13,935	82,065
2,600	76,050	1162.2	11,040	65,010	104,000	1589.1	15,095	88,905
2,800	81,900	1251.6	11,890	70,010	112,000	1711.4	16,260	95,740
3,000	87,750	1341.0	12,740	75,010	120,000	1833.6	17,420	102,580
3,200	93,600	1430.4	13,590	80,010	128,000	1855.8	18,580	109,420
3,400	99,450	1519.8	14,440	85,010	136,000	2078.1	19,740	116,260
3,600	105,300	1609.2	15,285	90,015	144,000	2200.3	20,905	123,095
3,800	111,150	1698.6	16,135	95,015	152,000	2322.6	22,065	129,935
4,000	117,000	1788.0	16,985	100,015	160,000	2444.8	23,225	136,775
4,200	122,850	1877.4	17,835	105,015	168,000	2567.0	24,385	143,615
4,400	128,700	1966.8	18,685	110,015	176,000	2689.3	25,550	150,450
4,600	134,550	2056.2	19,535	115,015	184,000	2811.5	26,710	157,290
4,800	140,400	2145.6	20,385	120,015	192,000	2933.8	27,870	164,130
5,000	146,250	2235.0	21,230	125,020	200,000	3056.0	29,030	170,970
5,200	152,100	2324.4	22,080	130,020	208,000	3178.2	30,195	177,805
5,400	157,950	2413.8	22,930	135,020	216,000	3300.5	31,355	184,645
5,600	163,800	2503.2	23,780	140,020	224,000	3422.7	32,515	191,485
5,800	169,650	2592.6	24,630	145,020	232,000	3545.0	33,675	198,325
6,000	175,500	2682.0	25,480	150,020	240,000	3667.2	34,840	205,160
6,200	181,350	2771.4	26,330	155,020	248,000	3789.4	36,000	212,000
6,400	187,200	2860.8	27,180	160,020	256,000	3911.7	37,160	218,840
6,600	193,050	2950.2	28,025	165,025	264,000	4033.9	38,320	225,680
6,800	198,900	3039.6	28,875	170,025	272,000	4156.2	39,485	232,515
7,000	204,750	3129.0	29,725	175,025	280,000	4278.4	40,645	239,355
7,200	210,600	3218.4	30,575	180,025	288,000	4400.6	41,805	246,195
7,400	216,450	3307.8	31,425	185,025	296,000	4522.9	42,965	253,035
7,600	222,300	3397.2	32,275	190,025	304,000	4645.1	44,130	259,870
7,800	228,150	3486.6	33,125	195,025	312,000	4767.4	45,290	266,710
8,000	234,000	3576.0	33,970	200,030	320,000	4889.6	46,450	273,550
8,200	239,850	3665.4	34,820	205,030	328,000	5011.8	47,610	280,390
8,400	245,700	3754.8	35,670	210,030	336,000	5134.1	48,775	287,225
8,600	251,550	3844.2	36,520	215,030	344,000	5256.3	49,935	294,065
8,800	257,400	3933.6	37,370	220,030	352,000	5378.6	51,095	300,905
9,000	263,250	4023.0	38,220	225,030	360,000	5500.8	52,260	307,740
9,200	269,100	4112.4	39,070	230,030	368,000	5623.0	53,420	314,580
9,400	274,950	4201.8	39,915	235,035	376,000	5745.3	54,580	321,420
9,600	280,800	4291.2	40,765	240,035	384,000	5867.5	55,740	328,260
9,800	286,650	4380.6	41,615	245,035	392,000	5989.8	56,905	335,095
10,000	292,500	4470.0	42,465	250,035	400,000	6112.0	58,065	341,935
10,200	298,350	4559.4	43,315	255,035	408,000	6234.2	59,225	348,775
10,400	304,200	4648.8	44,165	260,035	416,000	6356.5	60,385	355,615
10,600	310,050	4738.2	45,015	265,035	424,000	6478.7	61,550	362,450
10,800	315,900	4827.6	45,860	270,040	432,000	6601.0	62,710	369,290
11,000	321,750	4917.0	46,710	275,040	440,000	6723.2	63,870	376,130
11,200	327,600	5006.4	47,560	280,040	448,000	6845.4	65,030	382,970
11,400	333,450	5095.8	48,410	285,040	456,000	6967.7	66,195	389,805
11,600	339,300	5185.2	49,260	290,040	464,000	7089.9	67,355	396,645
11,800	345,150	5274.6	50,110	295,040	472,000	7212.2	68,515	403,485
12,000	351,000	5364.0	50,960	300,040	480,000	7334.4	69,675	410,325
12,200	356,850	5453.4	51,805	305,045	488,000	7456.6	70,840	417,160
12,400	362,700	5542.8	52,655	310,045	496,000	7578.9	72,000	424,000
12,600	368,550	5632.2	53,505	315,045	504,000	7701.1	73,160	430,840
12,800	374,400	5721.6	54,355	320,045	512,000	7823.4	74,320	437,680
13,000	380,250	5811.0	55,205	325,045	520,000	7945.6	75,485	444,515

[1]If a regular tool joint is inserted every 90 ft. all values for 7⅝-in. drill pipe will be increased about 2.7 percent, and for 8⅝-in. drill pipe about 4.0 percent.

They lead a ROUGH LIFE and they're made to stand it



WIRE line economy is so dependent upon long life and trouble-free operation that it pays to use only lines made to stand rough wear. For trouble-free operation you need wire lines that stand up under terrific strains—that avoid whipping at high speeds.

Each of the many types of American Tiger Brand Wire Lines is made to definite specifications of strength, flexibility, and elasticity. Extreme care in production, backed by constant research and inspection, assures lasting service.

American Tiger Brand Wire Lines are available in Standard (non-preformed) or Excellay (preformed) constructions. Each type and size is made to serve its own particular purpose and will give you complete economy and dependability. Our engineers will gladly work with you to determine which type is best suited to your needs.

American TIGER BRAND Wire Lines

AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago and New York

COLUMBIA STEEL COMPANY, Russ Building, San Francisco

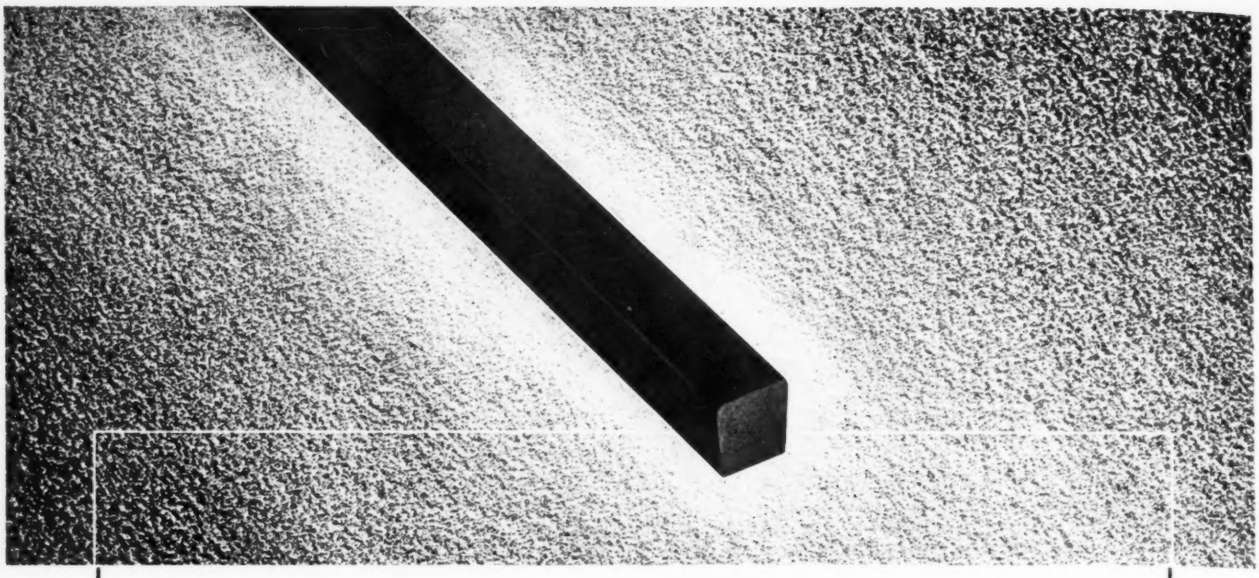
United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

VELOCITY[1] OF FLOW, FT. PER SEC., THROUGH 1½-IN. TUBING

Rate of production, bbl. per day	Gas-oil ratio, cu. ft. per bbl.	Tubing pressure at casinghead, lb. per sq. in. gauge								
		0	25	50	75	100	125	150	175	200
50	1000	41.2	15.4	9.5	6.9	5.5	4.5	3.9	3.4	3.0
100		82.3	30.8	19.1	13.9	11.0	9.1	7.8	6.8	6.1
150		123.5	46.2	28.6	20.8	16.4	13.6	11.7	10.2	9.1
200		164.7	61.6	38.1	27.8	21.9	18.1	15.5	13.6	12.1
250		205.8	76.9	47.7	34.7	27.4	22.7	19.4	17.0	15.2
300		247.0	92.3	57.2	41.6	32.9	27.2	23.3	20.4	18.2
350		288.2	107.7	66.7	48.6	38.3	31.8	27.2	23.8	21.2
400		329.3	123.1	76.2	55.5	43.8	36.3	31.1	27.2	24.3
50	1250	51.4	19.2	11.9	8.6	6.8	5.6	4.8	4.2	3.7
100		102.8	38.4	23.7	17.2	13.6	11.2	9.6	8.4	7.5
150		154.2	57.5	35.6	25.8	20.4	16.8	14.4	12.6	11.2
200		205.6	76.7	47.4	34.5	27.2	22.5	19.2	16.8	14.9
250		257.0	95.9	59.3	43.1	33.9	28.1	24.0	21.0	18.7
300		308.4	115.1	71.1	51.7	40.7	33.7	28.8	25.2	22.4
350		359.8	134.2	83.0	60.3	47.5	39.3	33.6	29.4	26.1
400		411.2	153.4	94.8	68.9	54.3	44.9	38.4	33.6	29.9
50	1500	61.6	23.0	14.2	10.3	8.1	6.7	5.7	5.0	4.4
100		123.3	45.9	28.4	20.6	16.2	13.4	11.4	10.0	8.9
150		184.9	68.9	42.5	30.9	24.3	20.1	17.1	15.0	13.3
200		246.5	91.9	56.7	41.2	32.4	26.8	22.8	20.0	17.7
250		308.2	114.8	70.9	51.5	40.5	33.5	28.6	24.9	22.2
300		369.8	137.8	85.1	61.8	48.6	40.1	34.3	29.9	26.6
350		431.4	160.8	99.3	72.0	56.7	46.8	40.0	34.9	31.0
400		493.1	183.7	113.4	82.3	64.8	53.5	45.7	39.9	35.5
50	1750	71.9	26.8	16.5	12.0	9.4	7.8	6.6	5.8	5.1
100		143.7	53.5	33.0	23.9	18.8	15.5	13.2	11.6	10.3
150		215.6	80.3	49.5	35.9	28.2	23.3	19.9	17.3	15.4
200		287.5	107.0	66.0	47.9	37.6	31.1	26.5	23.1	20.5
250		359.3	133.8	82.5	59.8	47.1	38.8	33.1	28.9	25.7
300		431.2	160.5	99.0	71.8	56.5	46.6	39.7	34.7	30.8
350		503.1	187.3	115.5	83.8	65.9	54.4	46.4	40.5	35.9
400		574.9	214.0	132.0	95.8	75.3	62.1	53.0	46.2	41.1
50	2000	82.1	30.5	18.8	13.6	10.7	8.8	7.5	6.6	5.8
100		164.2	61.1	37.7	27.3	21.4	17.7	15.1	13.1	11.7
150		246.3	91.6	56.5	40.9	32.2	26.5	22.6	19.7	17.5
200		328.4	122.2	75.3	54.6	42.9	35.4	30.1	26.3	23.3
250		410.5	152.7	94.2	68.2	53.6	44.2	37.7	32.9	29.2
300		492.6	183.3	113.0	81.9	64.3	53.1	45.2	39.4	35.0
350		574.7	213.8	131.8	95.5	75.1	61.9	52.8	46.0	40.8
400		656.8	244.4	150.7	109.2	85.8	70.8	60.3	52.6	46.7
50	2250	92.3	34.3	21.2	15.3	12.0	9.9	8.5	7.4	6.5
100		184.7	68.7	42.3	30.6	24.1	19.8	16.9	14.7	13.1
150		277.0	103.0	63.5	46.0	36.1	29.8	25.4	22.1	19.6
200		369.3	137.3	84.6	61.3	48.1	39.7	33.8	29.5	26.1
250		461.7	171.7	105.8	76.6	60.2	49.6	42.3	36.8	32.7
300		554.0	206.0	126.9	91.9	72.2	59.5	50.7	44.2	39.2
350		646.4	240.3	148.1	107.3	84.2	69.5	59.2	51.6	45.8
400		738.7	274.7	169.3	122.6	96.3	79.4	67.6	58.9	52.3
50	2500	102.6	38.1	23.5	17.0	13.3	11.0	9.4	8.2	7.2
100		205.1	76.2	47.0	34.0	26.7	22.0	18.7	16.3	14.5
150		307.7	114.4	70.4	51.0	40.0	33.0	28.1	24.5	21.7
200		410.3	152.5	93.9	68.0	53.4	44.0	37.5	32.6	28.9
250		512.8	190.6	117.4	85.0	66.7	55.0	46.8	40.8	36.2
300		615.4	228.7	140.9	102.0	80.1	66.0	56.2	49.0	43.4
350		718.0	266.9	164.4	119.0	93.4	77.0	65.5	57.1	50.7
400		820.6	305.0	187.9	136.0	106.8	88.0	74.9	65.3	57.9

[1]Solution and condensation under pressure are not considered; hence the values are maxima.



Slightly WEDGE-Shaped WIRE

Milled Groove

You give your production an opening wedge when you install Layne Screen. The wedge-shaped wire, wrapped with the small edge next to the pipe produces a wedge-shaped opening which flares toward the pipe.

Anything entering the outside screening point will flow on through screen and perforations and be pumped out. This eliminates clogging and sand cutting.

This wedge-shaped wire is made to our own specifications, and is available in the following materials, Admiralty Brass, Bronze, Galvanized Steel, Nickel or Enduro (non-corrosive) to suit specific conditions.

THE LAYNE

SCREENS

LAYNE & BOWLER COMPANY

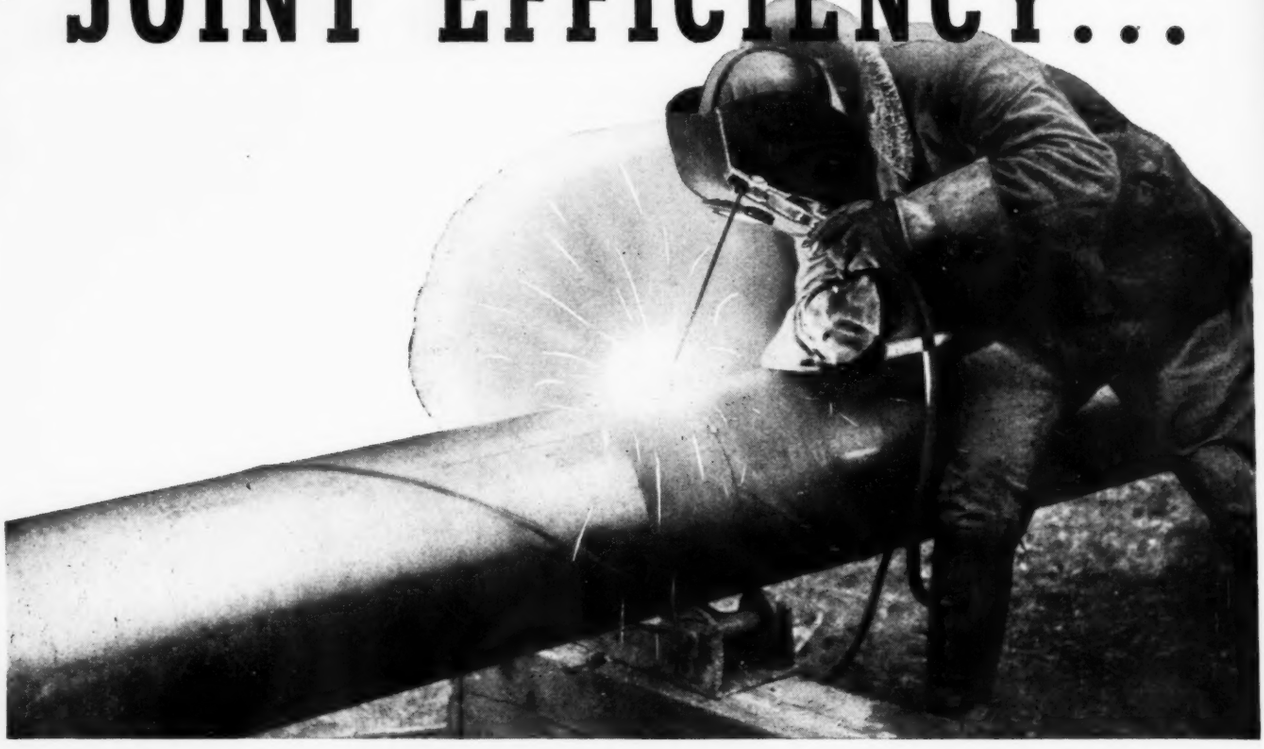
HOUSTON, TEXAS

EXPORT OFFICE: Room 1636, 30 Rockefeller Plaza, New York, New York

CAPACITY OF BOLTED STEEL TANKS, 42-GAL. BBL.

5,000 bbl. A. P. I. tank						10,000 bbl. A. P. I. tank					
Ft.	In.	Gross	Net: Gross less deadwood	Net less: 2 percent	Net less: 3 percent	Ft.	In.	Gross	Net: Gross less deadwood	Net less: 2 percent	Net less: 3 percent
	1/16	1.0875	1.0872	1.0655	1.0546		1/16	2.2023	2.2017	2.1577	2.1356
	1/8	2.1751	2.1745	2.1310	2.1093		1/8	4.4045	4.4034	4.3153	4.2713
	3/16	3.2626	3.2617	3.1965	3.1639		3/16	6.6068	6.6051	6.4730	6.4069
	1/4	4.3501	4.3490	4.2620	4.2185		1/4	8.8090	8.8067	8.6306	8.5425
	5/16	5.4377	5.4362	5.3275	5.2731		5/16	11.0113	11.0084	10.7883	10.6782
	3/8	6.5252	6.5235	6.3930	6.3278		3/8	13.2135	13.2101	12.9459	12.8138
	7/16	7.6127	7.6107	7.4585	7.3824		7/16	15.4158	15.4118	15.1036	14.9495
	1/2	8.7003	8.6980	8.5240	8.4370		1/2	17.6180	17.6135	17.2612	17.0851
	9/16	9.7878	9.7852	9.5895	9.4917		9/16	19.8203	19.8152	19.4189	19.2207
	5/8	10.8753	10.8725	10.6550	10.5463		5/8	22.0225	22.0169	21.5765	21.3564
	11/16	11.9629	11.9597	11.7205	11.6009		11/16	24.2248	24.2186	23.7342	23.4920
	3/4	13.0504	13.0470	12.7860	12.6555		3/4	26.4270	26.4202	25.8918	25.6276
	13/16	14.1379	14.1342	13.8515	13.7102		13/16	28.6293	28.6219	28.0495	27.7633
	7/8	15.2255	15.2215	14.9170	14.7648		7/8	30.8316	30.8236	30.2071	29.8989
	15/16	16.3130	16.3087	15.9825	15.8194		15/16	33.0338	33.0253	32.3648	32.0345
	1	17.4005	17.3959	17.0480	16.8741		1	35.2361	35.2270	34.5225	34.1702
	2	34.8010	34.7919	34.0960	33.7481		2	70.4721	70.4540	69.0449	68.3404
	3	52.2016	52.1878	51.1440	50.6222		3	105.7082	105.6810	103.5674	102.5106
	4	69.6021	69.5838	68.1920	67.4963		4	140.9443	140.9080	138.0898	136.6807
	5	87.0026	86.9797	85.2400	84.3703		5	176.1803	176.1350	172.6123	170.8509
	6	104.4031	104.3757	102.2880	101.2444		6	211.4164	211.3620	207.1347	205.0211
	7	121.8036	121.7716	119.3360	118.1185		7	246.6525	246.5890	241.6572	239.1913
	8	139.2042	139.1675	136.3840	134.9925		8	281.8885	281.8160	276.1796	273.3615
	9	156.6047	156.5635	153.4320	151.8666		9	317.1246	317.0430	310.7021	307.5317
	10	174.0052	173.9594	170.4800	168.7407		10	352.3607	352.2700	345.2246	341.7019
	11	191.4057	191.3554	187.5280	185.6147		11	387.5967	387.4970	379.7470	375.8720
1		208.8062	208.7513	204.5763	202.4888	1		422.8328	422.7239	414.2695	410.0422
2		417.6125	417.5027	409.1526	404.9776	2		845.6656	845.4479	828.5389	820.0845
3		626.4187	626.2540	613.7286	607.4663	3		1268.4984	1268.1718	1242.8084	1230.1267
4		835.2249	835.0053	818.3052	809.9551	4		1691.3311	1690.8958	1657.0779	1640.1689
5		1044.0312	1043.7566	1022.8815	1012.4439	5		2114.1639	2113.6197	2071.3474	2050.2111
6		1252.8374	1252.5080	1227.4578	1214.9327	6		2536.9967	2536.3437	2485.6168	2460.2534
7		1461.6437	1461.2593	1432.0341	1417.4215	7		2959.8295	2959.0676	2899.8863	2870.2956
8		1670.4499	1670.0106	1636.6104	1619.9103	8		3382.6623	3381.7916	3314.1558	3280.3378
9		1879.2561	1878.7619	1841.1867	1822.3990	9		3805.4951	3804.5155	3728.4252	3690.3801
10		2088.0624	2087.5133	2045.7630	2024.8878	10		4228.3278	4227.2395	4142.6947	4100.4223
11		2296.8686	2296.2646	2250.3393	2227.3766	11		4651.1606	4649.9634	4556.9642	4510.4645
12		2505.6748	2505.0159	2454.9156	2429.8654	12		5073.9934	5072.6874	4971.2337	4920.5068
13		2714.4811	2713.7672	2659.4919	2632.3542	13		5496.8262	5495.4113	5385.5031	5330.5490
14		2923.2873	2922.5186	2864.0682	2834.8430	14		5919.6590	5918.1353	5799.7726	5740.5912
15		3132.0936	3131.2699	3068.6445	3037.3317	15		6342.4918	6340.8592	6214.0421	6150.6334
16		3340.8998	3340.0212	3273.2208	3239.8205	16		6765.3246	6763.5832	6628.3115	6560.6757
17		3549.7060	3548.7725	3477.7971	3442.3093	17		7188.1573	7186.3071	7042.5810	6970.7179
18		3758.5123	3757.5239	3682.3734	3644.7981	18		7610.9901	7609.0311	7456.8505	7380.7601
19		3967.3185	3966.2752	3886.9497	3847.2869	19		8033.8229	8031.7550	7871.1199	7790.8024
20		4176.1247	4175.0265	4091.5260	4049.7757	20		8456.6557	8454.4790	8285.3894	8200.8446
21		4384.9310	4383.7778	4296.1023	4252.2644	21		8879.4885	8877.2029	8699.6589	8610.8868
22		4593.7372	4592.5292	4500.6786	4454.7532	22		9302.3213	9299.9269	9113.9284	9020.9291
23		4802.5435	4801.2805	4705.2549	4657.2420	23		9725.1541	9722.6508	9528.1978	9430.9713
24		5011.3497	5010.0318	4909.8312	4859.7308	24		10147.9867	10145.3748	9942.4673	9841.0135

100%
JOINT EFFICIENCY...

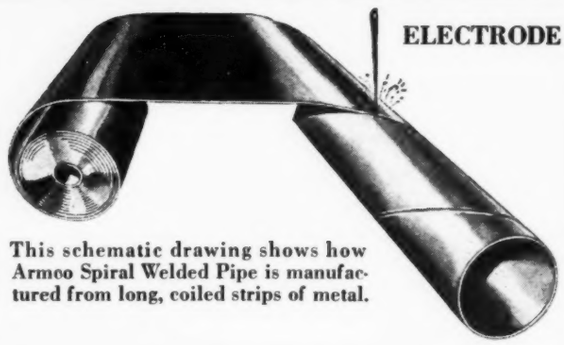


IN BOTH
PIPE AND FIELD WELDS

Oil men know from experience that the spiral welded joint on Armco pipe is *as strong as the steel itself.* And that means strength well in excess of your requirements.

Then too, since Armco Spiral Welded Pipe is supplied with plain bevelled ends, it can be *field welded faster and more economically* than heavy-end pipe. You'll also find that the finished welds are more ductile and uniform because only metals of the finest welding quality are used in the manufacture of Armco pipe.

Gain these extra advantages by ordering Armco Spiral Welded Pipe for that next gas gathering line or short transmission line. Diameters range from 6 to 36 inches; wall thicknesses from $\frac{7}{64}$ to $\frac{1}{2}$-inch, with individual lengths, fittings and coatings as required. Address: The American Rolling Mill Co., Pipe Sales Division, 703 Curtis Street, Middletown, Ohio, or 538 Mayo Building, Tulsa, Okla.



This schematic drawing shows how Armco Spiral Welded Pipe is manufactured from long, coiled strips of metal.

ARMCO

ARMCO SPIRAL WELDED PIPE